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Individual Learning Program

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AMATEUR RADIO

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CONTINUING
EDUCATION

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Module 4

EMISSION CHARACTERISTICS

ER-3701

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

MODULE OBJECTIVES

When have complete this module, you will be able to select:

1. The definition of a "spurious emission."
2. The definition of a "key click."
3. The definition of a "chirp."
4. The definition of "carrier frequency."
5. The definition of "frequency drift."
6. The definition of "continuous waves."
7. The definition of a "type Aϕ emission."
8. The definition of a "type A1 emission."
9. The characteristics of a good quality A1 emission.
10. A good method of keying a transmitter.
11. Methods of monitoring your transmitted signal.
12. A true statement concerning purity and stability of emissions.

MODULE PRETEST

This examination will test you knowledge of the material presented in this module. For each question, circle the mutiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare the answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than two questions, read this whole module.
- If you have less than two incorrect answers, you may either study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame) or you can skip this module and proceed to the next module.

1. Select the best definition of a spurious emission.

   A. A spurious emission is any radiation from a transmitter which causes wanted harmonics, clicks, or oscillations on either side of the operating frequency.
   B. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on the operating frequency.
   C. A spurious emission is any radiation from a receiver which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
   D. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
   E. None of the above.

2. Select the best definition of a key click.

   A. A key click is a spike on the operating frequency that is caused when you close or open a telegraph key.
   B. A key click is a spike on a frequency far removed from the operating frequency that is caused when you close or open a telegraph key.
   C. A key click is a spike on a nearby frequency that is caused only when you close a telegraph key.
   D. A key click is a spike on a nearby frequency that is caused only when you open a telegraph key.
   E. A key click is a spike on a nearby frequency that is caused when you close or open a telegraph key.

3. Select the best definition of chirp.

   A. Chirp is the name given a CW signal which changes slowly in frequency.
   B. Chirp is the name given a CW signal which changes quickly in frequency.
   C. Chirp is the name given an audio signal which changes slowly in frequency.
   D. Chirp is the name given an audio signal which changes quickly in frequency.
   E. All of the above.

4. Select the best definition of carrier frequency.

   A. Carrier frequency is always the frequency of the oscillator.
   B. Carrier frequency is the frequency of the signal that actually leaves the antenna.
   C. Carrier frequency is always the frequency of the first multiplier stage.
   D. Carrier frequency is the difference in frequency between the oscillator circuit and any multiplier stages that follow it.
   E. Carrier frequency is a spurious emission.

5. Select the best definition of frequency drift.

   A. Frequency drift is a fast change in the frequency of a signal.
   B. Frequency drift is the difference between the oscillator frequency and the resulting frequency of a multiplier stage.
   C. Frequency drift is the same thing as chirp.
   D. Frequency drift is a slow change in the frequency of a signal.
   E. None of the above.

6. Select the best definition of continuous waves.

   A. Continuous waves are radio waves that have a changing amplitude and are not modulated.
   B. Continuous waves are radio waves that have a constant amplitude and are voice modulated.

C. Continuous waves are radio waves that have a constant amplitude and are tone modulated.
D. Continuous waves are interrupted radio waves that are not modulated.
E. Continuous waves are radio waves that have a constant amplitude and are not modulated.

7. What type of emission is a steady, unmodulated carrier wave?

A. A2.
B. Aø.
C. A1.
D. F1.
E. Fø.

8. What type of emission is an interrupted, unmodulated carrier wave?

A. Aø.
B. A2.
C. A1.
D. F1.
E. F2.

9. Which of the following is characteristic of a good quality A1 emission?

A. The emission should have many spurious emissions and a pure note.
B. The emission should be free of spurious emissions and have a pure note.
C. The emission should have many clicks and a pure note.
D. The emission should have much chirp and a pure note.
E. None of the above.

10. Which of the following is the best place to key a transmitter?

A. A stage after the oscillator circuit.
B. The oscillator circuit.
C. A stage in front of the oscillator circuit.
D. The antenna.
E. The main power supply.

11. Which of the following is the best method of checking your transmitted signal?

A. Use an amateur band receiver.
B. Use a communications type receiver.
C. Use an oscilloscope.
D. Use reception reports from other stations.
E. None of the above.

12. Which of the following is a true statement concerning the frequency stability of an emitted carrier wave?

A. The carrier wave may vary in frequency as long as it ends up within an amateur band.
B. The carrier wave must be as constant as the state of the art permits.
C. The carrier wave may vary in frequency as long as it starts within an amateur band.
D. The carrier wave may vary in frequency as long as it stays within an amateur band.
E. None of the above.

PRETEST ANSWERS

Q	A	FRAME NO.
1.	D	(1)
2.	E	(2)
3.	B	(4)
4.	B	(7)
5.	D	(10)
6.	E	(13)
7.	B	(16)
8.	C	(19)
9.	B	(22)
10.	A	(25)
11.	C	(28)
12.	B	(31)

INTRODUCTION

All amateurs wish to transmit the best possible signal. This Module will teach you the terms associated with a transmitted signal and how to recognize some common problems. You will also learn how to check your signal for quality.

PROGRAMMED INSTRUCTION

1. Occasionally, you may hear another amateur mention "spurious emissions" (also called "spurious signals").

   A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.

   Spurious emissions are in violation of the Rules and Regulations because they can interfere with other stations.

   A spurious emission is any radiation from a transmitter which causes unwanted _____, _____, or _____ on either side of the operating frequency.

   harmonics, clicks, oscillations

2. When you suddenly close or open a telegraph key, a current surge or "spike" occurs. This spike can cause unwanted clicks on frequencies surrounding the operating frequency and could interfere with other communications.

   A click on a nearby frequency that is caused when you close or open a telegraph key is called a key click.

   A click on a nearby frequency that is caused when you close or open a telegraph key is called a _____ _____.

   key click

3. Which of the following is the correct definition of a spurious emission?

A. A spurious emission is any radiation from a transmitter which causes wanted harmonics, clicks, or oscillations on either side of the operating frequency.
B. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
C. A spurious emission is any radiation from a receiver which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
D. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on the operating frequency.
E. None of the above.

B

4. **The name given a CW signal which changes quickly in frequency (noticeable as a change in pitch) is called "chirp."**

Chirp is usually caused by an insufficient or poorly regulated power supply in the transmitter. A sudden load on the power supply, caused when you key the transmitter, causes the supply voltage to drop. This voltage drop, in turn, causes the transmitter frequency to change and causes a chirping sound.

The name given a CW signal which changes in frequency (noticeable as a change in pitch) is called _____.

chirp

5. Which of the following is the correct definition of a key click?

A. A key click is a spike on a nearby frequency that is caused when you close or open a telegraph key.
B. A key click is a spike on the operating frequency that is caused when you close or open a telegraph key.
C. A key click is a spike on a frequency far removed from the operating frequency that is caused when you close or open a telegraph key.
D. A key click is a spike on a nearby frequency that is caused only when you close a telegraph key.
E. A key click is a spike on a nearby frequency that is caused only when you open a telegraph key.

A

6. Select the best definition of a spurious emission.

A. A spurious emission is any radiation from a transmitter which causes wanted harmonics, clicks, or oscillations on either side of the operating frequency.
B. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on the operating frequency.
C. A spurious emission is any radiation from a receiver which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
D. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
E. None of the above.

D

7. A transmitter operates on a specific frequency which is determined by the oscillator circuit and any multiplier stages that follow it.

The frequency of the signal that actually leaves the transmitting antenna is called the carrier frequency.

The frequency of the signal that actually leaves the transmitting antenna is called the _____ _____.

carrier frequency

8. Which of the following is the best definition of chirp?

A. Chirp is the name given a CW signal which changes slowly in frequency.
B. Chirp is the name given a CW signal which changes quickly in frequency.
C. Chirp is the name given an audio signal which changes quickly in frequency.
D. Chirp is the name given an audio signal which changes slowly in frequency.
E. All of the above.

B

9. Select the best definition of a key click.

A. A key click is a spike on the operating frequency that is caused when you close or open a telegraph key.
B. A key click is a spike on a frequency far removed from the operating frequency that is caused when you close or open a telegraph key.
C. A key click is a spike on a nearby frequency that is caused only when you close a telegraph key.
D. A key click is a spike on a nearby frequency that is caused only when you open a telegraph key.
E. A key click is a spike on a nearby frequency that is caused when you close or open a telegraph key.

E

10. Some signals may change frequency slowly. This is usually caused by heat affecting the oscillator and could happen in a receiver as well as a transmitter.

A slow change in the frequency of a signal is called a frequency drift.

A slow change in the frequency of a signal is called a _____ _____.

frequency drift

11. Which of the following is the best definition of carrier frequency?

A. Carrier frequency is always the frequency of the oscillator.
B. Carrier frequency is always the frequency of the first multiplier stage.
C. Carrier frequency is the frequency of the signal that actually leaves the antenna.
D. Carrier frequency is the difference in frequency between the oscillator circuit and any multiplier stages that follow it.
E. Carrier frequency is an unwanted signal.

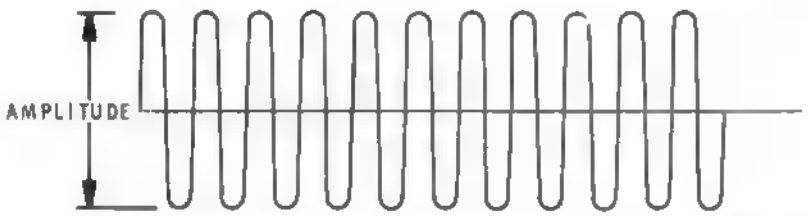
C

12. Select the best definition of chirp.

A. Chirp is the name given a CW signal which changes slowly in frequency.
B. Chirp is the name given a CW signal which changes quickly in frequency.
C. Chirp is the name given an audio signal which changes slowly in frequency.
D. Chirp is the name given an audio signal which changes quickly in frequency.
E. All of the above.

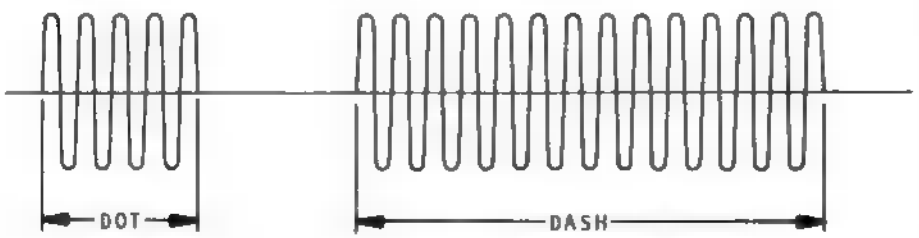
B

13. **Radio waves that have a constant amplitude (size) and are not modulated are called continuous waves (see Figure 4-1).**



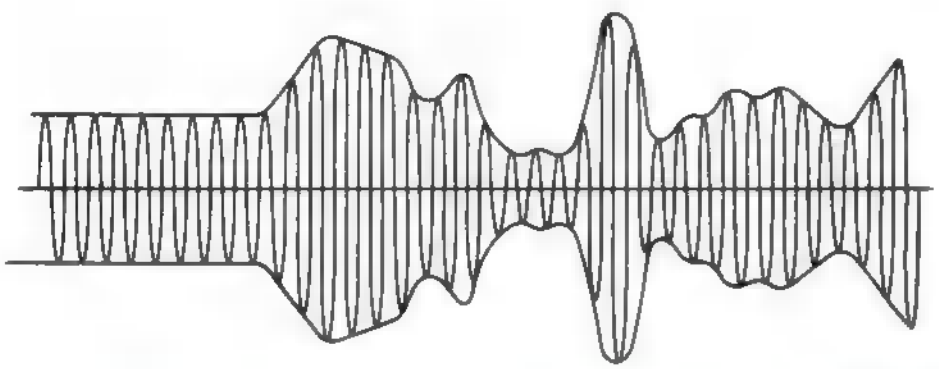
A CONTINUOUS WAVE **Figure 4-1**

To send code, we simply turn a continuous wave on and off for different lengths of time as shown in Figure 4-2.



THE MORSE LETTER A **Figure 4-2**

If we put speech on the continuous wave, it would look something like the wave shown in Figure 4-3.



CONTINUOUS WAVE WITH SPEECH ADDED **Figure 4-3**

Radio waves that have a constant amplitude and are not modulated are called _____ _____.

continuous waves

14. Which of the following is the best definition of frequency drift?

A. Frequency drift is a slow change in the frequency of a signal.
B. Frequency drift is a fast change in the frequency of a signal.
C. Frequency drift is the difference between the oscillator frequency and the resulting frequency of a multiple stage.
D. Frequency drift is the same thing as chirp.
E. None of the above.

A

15. Select the best definition of carrier frequency.

A. Carrier frequency is always the frequency of the oscillator.
B. Carrier frequency is the frequency of the signal that actually leaves the antenna.
C. Carrier frequency is always the frequency of the first multiplier stage.
D. Carrier frequency is the difference in frequency between the oscillator circuit and any multiplier stages that follow it.
E. Carrier frequency is a spurious emission.

B

16. **A steady, unmodulated carrier wave is called type A$\emptyset$ emission.**

A steady, unmodulated carrier wave is called type _____ emission.

A$\emptyset$

17. Which of the following is the best definition of continuous waves?

A. Continuous waves are radio waves that have a constant amplitude and are voice modulated.
B. Continuous waves are radio waves that have a changing amplitude and are not modulated.
C. Continuous waves are radio waves that have a constant amplitude and are tone modulated.
D. Continuous waves are radio waves that have a constant amplitude and are not modulated.
E. Continuous waves are interrupted radio waves that are not modulated.

D

18. Select the best definition of frequency drift.

A. Frequency drift is a fast change in the frequency of a signal.
B. Frequency drift is the difference between the oscillator frequency and the resulting frequency of a multiplier stage.
C. Frequency drift is the same thing as chirp.
D. Frequency drift is a slow change in the frequency of a signal.
E. None of the above.

D

19. **An interrupted, unmodulated carrier wave is called type A1 emission.**

As described in Module 1, type A1 emission is telegraphy (code) and is the only type of emission a novice may use.

An interrupted, unmodulated carrier wave is called type _____ emission.

A1

20. Which of the following is the best definition of type Aϕ emission?

A. Type Aϕ emission is a steady, tone-modulated carrier wave.
B. Type Aϕ emission is an interrupted, unmodulated carrier wave.
C. Type Aϕ emission is a steady, unmodulated carrier wave.
D. Type Aϕ emission is a steady, voice-modulated carrier wave.
E. Type Aϕ emission is a telegraph transmission.

C

21. Select the best definition of continuous waves.

A. Continuous waves are radio waves that have a changing amplitude and are not modulated.
B. Continuous waves are radio waves that have a constant amplitude and are voice modulated.
C. Continuous waves are radio waves that have a constant amplitude and are tone modulated.
D. Continuous waves are interrupted radio waves that are not modulated.
E. Continuous waves are radio waves that have a constant amplitude and are not modulated.

E

22. All amateurs strive to transmit the best possible signals. This reduces interference and makes the signals easier to listen to.

A good quality A1 emission should be free of any spurious emissions and have a pure note.

A good quality A1 emission should be free of any _____ _____ and have a pure note.

spurious emissions

23. What type of emission is an interrupted, unmodulated carrier wave?

A. A1.
B. A2.
C. F1.
D. F2.
E. Aϕ.

A

24. What type of emission is ■ steady, unmodulated carrier wave?

A. A2.
B. Aϕ.
C. A1.
D. F1.
E. Fϕ.

B

25. A transmitter may be keyed (turned on and off) in many ways. One method is to key the oscillator. This method is not desirable since it usually causes the oscillator frequency to change slightly, which causes chirp.

The best method of keying is to key a stage after the oscillator circuit.

Keying ■ stage after the oscillator helps prevent frequency changes and ensures that the transmitter is completely on or off.

The best method of keying is to key a stage _____ the _____ circuit.

after oscillator

26. Which of the following is characteristic of a good quality A1 emission?

A. The emission should have many spurious emissions and a pure note.
B. The emission should have much chirp and a pure note.
C. The emission should have many clicks and a pure note.
D. The emission should be free of any spurious emissions and have a pure note.
E. None of the above.

D

27. What type of emission is an interrupted, unmodulated carrier wave?

A. A0.
B. A2.
C. A1.
D. F1.
E. F2.

C

28. To make sure your transmitted signal is clean of spurious emissions, you should make regular checks.

The best method of checking your transmitted signal is to use an oscilloscope or a good quality receiver.

The oscilloscope is recommended over a receiver since it gives a visual display of the signal. Also, a receiver located anywhere near the transmitter is easily overloaded by the strong signal and can give a false representation of the actual signal.

The best method of checking your transmitted signal is to use an _____ or a good quality _____.

oscilloscope receiver

29. Which of the following is the best place to key a transmitter?

A. The oscillator circuit.
B. A stage in front of the oscillator circuit.
C. A stage after the oscillator circuit.
D. Any of the above.
E. None of the above.

C

30. Which of the following is characteristic of a good quality A1 emission?

A. The emission should have many spurious emissions and a pure note.
B. The emission should be free of spurious emissions and have a pure note.
C. The emission should have many clicks and a pure note.
D. The emission should have much chirp and a pure note.
E. None of the above.

B

31. **The Rules and Regulations state that the frequency of an emitted carrier wave must be as constant as the state of the art permits.**

The reason for the above rule is to prevent interference with other communications. Also, amateurs must keep their radio equipment up to the latest standards.

The frequency of an emitted carrier wave must be as _____ as the state of the art permits.

constant

32. Which of the following is the best method of checking your transmitted signal?

A. Use a communications-type receiver.
B. Use an amateur band receiver.
C. Use an oscilloscope.
D. Use reception reports from another station.
E. Any of the above.

C

33. Which of the following is the best place to key a transmitter?

A. A stage after the oscillator circuit.
B. The oscillator circuit.
C. A stage in front of the oscillator circuit.
D. The antenna.
E. The main power supply.

A

34. Which of the following is a true statement concerning the frequency stability of an emitted carrier wave?

A. The carrier wave may vary in frequency as long as it stays within an amateur band.
B. The carrier wave may vary in frequency as long as it begins within an amateur band.
C. The carrier wave may vary in frequency as long as it ends up within an amateur band.
D. The carrier wave must be as constant as the state of the art permits.
E. None of the above.

D

35. Which of the following is the best method of checking your transmitted signal?

A. Use an amateur band receiver.
B. Use a communications-type receiver.
C. Use an oscilloscope.
D. Use reception reports from other stations.
E. None of the above.

C

36. Which of the following is a true statement concerning the frequency stability of an emitted carrier wave?

A. The carrier wave may vary in frequency as long as it ends up within an amateur band.
B. The carrier wave must be as constant as the state of the art permits.
C. The carrier wave may vary in frequency as long as it starts within an amateur band.
D. The carrier wave may vary in frequency as long as it stays within an amateur band.
E. None of the above.

B

Proceed to the audio review of "The RST System of Reporting" (Tape 1, Side B).

MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than two questions, go back and reread this whole module.
- If you have less than two incorrect answers, go back and study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame). Then proceed to the next module.

1. Select the best definition of a spurious emission.

   A. A spurious emission is any radiation from a transmitter which causes wanted harmonics, clicks, or oscillations on either side of the operating frequency.
   B. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on the operating frequency.
   C. A spurious emission is any radiation from a receiver which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
   D. A spurious emission is any radiation from a transmitter which causes unwanted harmonics, clicks, or oscillations on either side of the operating frequency.
   E. None of the above.

2. Select the best definition of a key click.

   A. A key click is a spike on the operating frequency that is caused when you close or open a telegraph key.
   B. A key click is a spike on a frequency far removed from the operating frequency that is caused when you close or open a telegraph key.
   C. A key click is a spike on a nearby frequency that is caused only when you close a telegraph key.
   D. A key click is a spike on a nearby frequency that is caused only when you open a telegraph key.
   E. A key click is a spike on a nearby frequency that is caused when you close or open a telegraph key.

3. Select the best definition of chirp.

   A. Chirp is the name given a CW signal which changes slowly in frequency.
   B. Chirp is the name given a CW signal which changes quickly in frequency.
   C. Chirp is the name given an audio signal which changes slowly in frequency.
   D. Chirp is the name given an audio signal which changes quickly in frequency.
   E. All of the above.

4. Select the best definition of carrier frequency.

   A. Carrier frequency is always the frequency of the oscillator.
   B. Carrier frequency is the frequency of the signal that actually leaves the antenna.
   C. Carrier frequency is always the frequency of the first multiplier stage.
   D. Carrier frequency is the difference in frequency between the oscillator circuit and any multiplier stages that follow it.
   E. Carrier frequency is a spurious emission.

5. Select the best definition of frequency drift.

   A. Frequency drift is a fast change in the frequency of a signal.
   B. Frequency drift is the difference between the oscillator frequency and the resulting frequency of a multiplier stage.
   C. Frequency drift is the same thing as chirp.
   D. Frequency drift is a slow change in the frequency of a signal.
   E. None of the above.

6. Select the best definition of continuous waves.

   A. Continuous waves are radio waves that have a changing amplitude and are not modulated.
   B. Continuous waves are radio waves that have a constant amplitude and are voice modulated.
   C. Continuous waves are radio waves that have a constant amplitude and are tone modulated.

D. Continuous waves are interrupted radio waves that are not modulated.
E. Continuous waves are radio waves that have a constant amplitude and are not modulated.

7. What type of emission is a steady, unmodulated carrier wave?

A. A2.
B. AØ.
C. A1.
D. F1.
E. FØ.

8. What type of emission is an interrupted, unmodulated carrier wave?

A. AØ.
B. A2.
C. A1.
D. F1.
E. F2.

9. Which of the following is characteristic of a good quality A1 emission?

A. The emission should have many spurious emissions and a pure note.
B. The emission should be free of spurious emissions and have a pure note.
C. The emission should have many clicks and a pure note.
D. The emission should have much chirp and a pure note.
E. None of the above.

10. Which of the following is the best place to key a transmitter?

A. A stage after the oscillator circuit.
B. The oscillator circuit.
C. A stage in front of the oscillator circuit.
D. The antenna.
E. The main power supply.

11. Which of the following is the best method of checking your transmitted signal?

    A. Use an amateur band receiver.
    B. Use a communications type receiver.
    C. Use an oscilloscope.
    D. Use reception reports from other stations.
    E. None of the above.

12. Which of the following is a true statement concerning the frequency stability of an emitted carrier wave?

    A. The carrier wave may vary in frequency as long as it ends up within an amateur band.
    B. The carrier wave must be as constant as the state of the art permits.
    C. The carrier wave may vary in frequency as long as it starts within an amateur band.
    D. The carrier wave may vary in frequency as long as it stays within an amateur band.
    E. None of the above.

EXAMINATION ANSWERS

Q	A	FRAME NO.
1.	D	(1)
2.	E	(2)
3.	B	(4)
4.	B	(7)
5.	D	(10)
6.	E	(13)
7.	■	(16)
8.	C	(19)
9.	B	(22)
10.	A	(25)
11.	C	(28)
12.	B	(31)

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Module 5

ELECTRICAL PRINCIPLES

ER-3701

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

MODULE OBJECTIVES

When you complete this module, you will be able to select or determine:

1. The definition of current.
2. The definition of electromotive force.
3. The definition of resistance.
4. The definition of capacitance.
5. The definition of inductance.
6. The definition of alternating current.
7. The basic unit of measurement for frequency.
8. The number of hertz in one kilohertz.
9. The number of hertz in one megahertz.
10. The definition of direct current.
11. The definition of voltage drop.
12. The definition of electrical power.
13. The definition of rectification.
14. The definition of a harmonic.
15. The unit of measurement for electromotive force.
16. The unit of measurement for current.
17. The unit of measurement for resistance.
18. The unit of measurement for power.

19. The unit of measurement for inductance.

20. The unit of measurement for capacitance.

21. The meaning of electrical energy.

22. The amount of current in a circuit when you are given the voltage and resistance.

23. The amount of voltage in a circuit when you are given the current and resistance.

24. The amount of power in a circuit when you are given the voltage and current.

25. The total resistance of two or more resistances in series.

26. The total resistance of two or more resistances in parallel.

27. The current through the components in a series circuit.

28. The voltage across the components in a series circuit.

29. The current through the branches of a parallel circuit.

30. The voltage across the branches of a parallel circuit.

31. The meaning of "magnetic field."

32. The meaning of "magnetomotive force."

MODULE PRETEST

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare the answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than six questions, read this whole module.
- If you have less than six incorrect answers, you may either study those frames pertaining to the questions you missed (the number in the parentheses following the correct answer refers you to the proper frame) or you can skip this module and proceed to the next module.

1. Select the best definition of current.

   A. A difference of potential.
   B. The opposition to the flow of electrons.
   C. The ability to store electrical energy.
   D. The amount of electrons flowing through a circuit.
   E. The ability to store magnetic energy.

2. Which of the following best describes electromotive force?

   A. The amount of electrons flowing through a circuit.
   B. A difference potential.
   C. The opposition to the flow of current.
   D. An electron.
   E. An atom.

3. Which of the following best describes resistance?

   A. A difference of potential.
   B. The ability to store electrical energy.
   C. The ability to store magnetic energy.
   D. An electromotive force.
   E. The opposition to the flow of current.

4. Select the best definition of capacitance.

   A. The ability to store electrical energy.
   B. The ability to store magnetic energy.
   C. A difference of potential.
   D. The amount of electrons flowing through a circuit.
   E. The opposition to the flow of current.

5. Which of the following best describes inductance?

   A. The ability to store electrical energy.
   B. The ability to store magnetic energy.
   C. The opposition to the flow of current.
   D. A difference of potential.
   E. The amount of electrons flowing through a circuit.

6. Select the best definition of alternating current.

   A. A current flow that changes direction at a given rate.
   B. A current flow that always flows in one direction.
   C. A frequency modulated wave.
   D. An amplitude modulated wave.
   E. None of the above.

7. Which of the following is the **basic** unit of measurement for frequency?

   A. The kilohertz.
   B. The kilocycle.
   C. The megacycle.
   D. The hertz.
   E. The megahertz.

8. How many hertz are in one kilohertz?

   A. 10.
   B. 100.
   C. 1000.
   D. 1,000,000.
   E. 1.

9. How many hertz are in one megahertz?

A. 1.
B. 10.
C. 100.
D. 1000.
E. 1,000,000.

10. Which of the following best describes direct current?

A. A current flow that changes direction at a given rate.
B. A current flow that always travels in a straight line.
C. A current flow that comes straight from the source.
D. A current flow that always flows in one direction.
E. None of the above.

11. Select the best definition of voltage drop.

A. A change in voltage due to a short circuit.
B. A change in voltage due to an open circuit.
C. The voltage that appears only across an inductance.
D. The voltage that appears only across a capacitance.
E. The voltage that appears across any component in a circuit.

12. Which of the following best describes electrical power?

A. A difference of potential.
B. The rate at which current does work.
C. The ability to store electrical energy.
D. The ability to store magnetic energy.
E. The ability of a circuit to change AC to DC.

13. Select the best definition of rectification.

A. The process of changing AC into DC.
B. The ability to change inductance into capacitance.
C. The ability to change capacitance into inductance.
D. The ability to correct a problem.
E. The process of changing DC into AC.

14. Which of the following best describes a harmonic?

A. A frequency that is less than an original frequency.
B. A frequency that is a whole multiple of an original frequency.
C. A frequency that is an even multiple of another frequency.
D. A frequency that is an odd multiple of another frequency.
E. A frequency that is a fraction of another frequency.

15. What is the unit of measurement for electromotive force?

A. The farad.
B. The ampere.
C. The henry.
D. The volt.
E. The ohm.

16. What is the unit of measurement for current?

A. The watt.
B. The ohm.
C. The volt.
D. The henry.
E. The ampere.

17. What is the unit of measurement for resistance?

A. The farad.
B. The ohm.
C. The ampere.
D. The henry.
E. The watt.

18. What is the unit of measurement for power?

A. The ampere.
B. The watt.
C. The volt.
D. The farad.
E. The ohm.

19. What is the unit of measurement for inductance?

A. The farad.
B. The ampere.
C. The hertz.
D. The watt.
E. The henry.

20. What is the unit of measurement for capacitance?

A. The watt.
B. The hertz.
C. The ampere.
D. The farad.
E. The henry.

21. Which of the following best describes electrical energy?

A. The ability to store electrical work.
B. The ability to store magnetic work.
C. The ability to dissipate work.
D. The ability to store voltage.
E. The ability to do electrical work.

22. How much current flows in the circuit shown below?

A. 2 amperes.
B. 50 amperes.
C. 0.5 amperes.
D. 5 amperes.
E. 10 amperes.

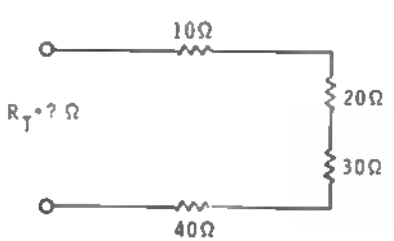
23. What is the battery voltage in the circuit shown below?

A. 33.3 volts.
B. .03 volts.
C. 3000 volts.
D. 300 volts.
E. 3 volts.

24. How much power is used in the circuit shown below?

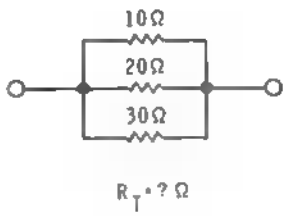
A. 500 watts.
B. 250 watts.
C. 50 watts.
D. 10 watts.
E. 2 watts.

25. What is the total resistance of the circuit shown below?



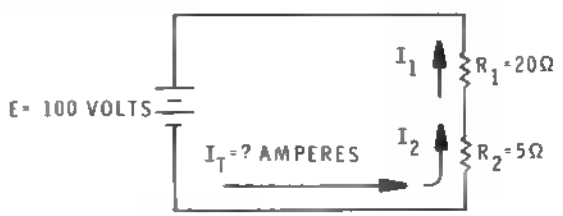
A. 100 Ω.
B. .208 Ω.
C. 2.5 Ω.
D. 1000 Ω.
E. 10 Ω.

26. What is the total resistance of the following circuit?



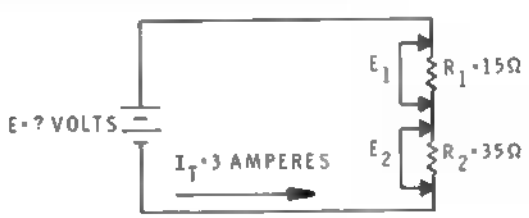
A. 6.667 Ω.
B. 60 Ω.
C. 7.5 Ω.
D. 12 Ω.
E. 5.45 Ω.

27. How much current flows through resistor R_2 in the following circuit?



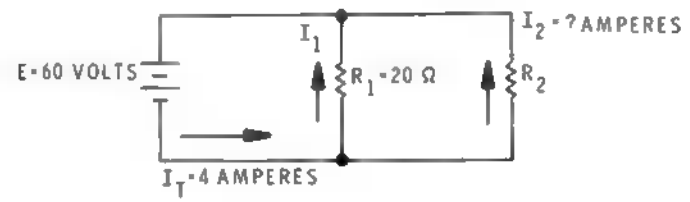
A. 5 amperes.
B. 4 amperes.
C. 20 amperes.
D. 25 amperes.
E. Can't determine from information given.

28. What is the battery voltage in the following circuit?



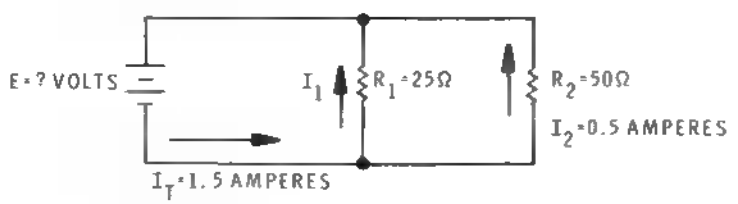
A. Can't be determined.
B. 45 volts.
C. 150 volts.
D. 105 volts.
E. 31.5 volts.

29. How much current flows through resistor R_2 in the following circuit?



A. Can't be determined.
B. 1 ampere.
C. 4 amperes.
D. 3 amperes.
E. 12 amperes.

30. What is the battery voltage in the following circuit?



A. 75 volts.
B. 37.5 volts.
C. 100 volts.
D. 112.5 volts.
E. 25 volts.

31. Select the best definition of a magnetic field.

A. A magnetic field is produced by the invisible lines of force that surround a magnet.
B. A magnetic field is formed by the invisible lines of force that surround any metallic object.
C. A magnetic field is formed by the invisible lines of force that surround any iron or steel object.
D. A magnetic field is formed by the visible lines of force that surround a magnet.
E. None of the above.

32. Select the best definition of magnetomotive force.

A. Magnetomotive force is a force which reduces a magnetic field.
B. Magnetomotive force is a force which produces a magnetic field.
C. Magnetomotive force is a force that is only produced by magnetic material.
D. Magnetomotive force is a force that is only produced by an electromagnet.
E. Magnetomotive force is the invisible lines of force that surround a magnet.

PRETEST ANSWERS

Q	A	FRAME NO.	Q	A	FRAME NO.
1.	D.	(1)	17.	B.	(46)
2.	B.	(2)	18.	B.	(49)
3.	E.	(4)	19.	E.	(52)
4.	A.	(7)	20.	D.	(55)
5.	B.	(10)	21.	E.	(58)
6.	A.	(13)	22.	A.	(61)
7.	D.	(16)	23.	D.	(64)
8.	C	(19)	24.	B.	(67)
9.	E.	(22)	25.	A.	(70)
10.	D.	(25)	26.	E.	(73)
11.	E.	(28)	27.	B.	(76)
12.	B.	(31)	28.	C.	(79)
13.	A.	(34)	29.	B.	(82)
14.	B.	(37)	30.	E.	(85)
15.	D.	(40)	31.	A.	(88)
16.	E.	(43)	32.	B.	(91)

INTRODUCTION

In this module about electrical principles, you will learn the terms and concepts associated with simple electronic circuits. You will also learn some basic theory and mathematical calculations concerning series and parallel circuits. Last, you will learn some fundamental laws of magnetism.

PROGRAMMED INSTRUCTION

1. All matter is made up of tiny particles called "atoms." Atoms are further broken down into even smaller particles called "protons," "neutrons," and "electrons." Controlling electrons is the main function of all electronic circuits.

   Current is the amount of electrons flowing through a circuit.

   As you will learn later, the amount of current flow depends upon the pressure applied to the circuit and the amount of resistance the circuit has.

   Current is the amount of _____ flowing through a circuit.

   electrons

2. Electromotive force (EMF) is a difference of potential.

Electromotive force can be thought of as the "pressure" needed to push electrons through a circuit. This pressure is expressed as a voltage and can be produced by a battery, ■ generator, etc.

Figure 5-1 shows two simple circuits. Each circuit contains a battery and a wire. Note that the larger the battery, the larger the amount of current flow through the wire. Also note that electrons flow from the negative (−) end of the battery to the positive (+) end of the battery.

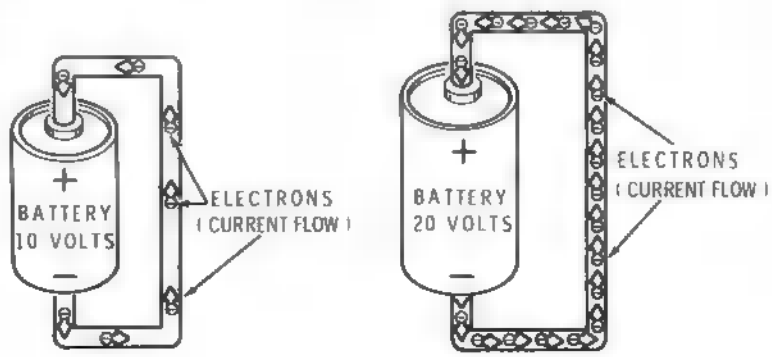


Figure 5-1

Electromotive force (EMF) is a _____ of _____.

difference potential

3. Select the best definition of current.

A. Current is the amount of electrons flowing through a circuit.
B. Current is the opposition to the flow of electrons.
C. Current is a difference of potential.
D. Current is the same as pressure.
E. Current is an electromotive force.

A

4. Resistance is the opposition to the flow of current.

If you insert a light bulb in the simple circuit mentioned earlier (see Figure 5-2, Part A), you have opposition to the flow of current through the circuit. If you add another bulb to the circuit, the opposition becomes greater (see Part B).

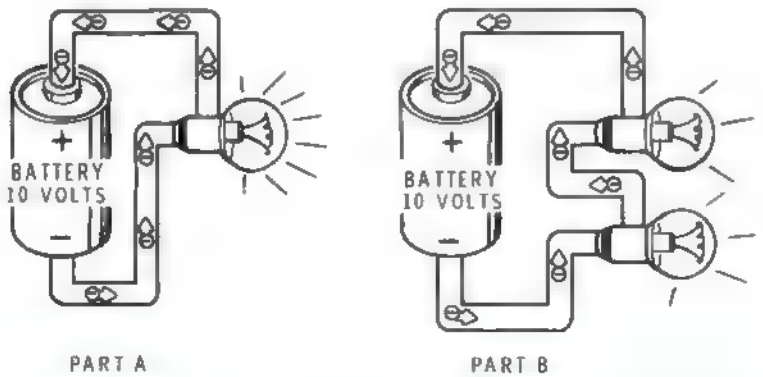


Figure 5-2

Resistance is the _____ to the flow of current.

opposition

5. Select the best definition of electromotive force.

A. Electromotive force is the amount of current that flows through a circuit.
B. Electromotive force is the amount of electrons that flow through a circuit.
C. Electromotive force is a difference of potential.
D. Electromotive force is the weight of electrons.
E. Electromotive force is the size of a group of electrons.

C

6. "The amount of electrons flowing through a circuit" is the definition for which of the following?

A. Electromotive force.
B. Resistance.
C. Capacitance.
D. Current.
E. Voltage.

D

7. **Capacitance is a measurement of the ability to store electrical energy.**

A capacitor is formed by two conductive plates which are separated by an insulator. The size of the plates mainly determines the amount of capacitance, although the kind of insulator and the spacing between the plates also affect it.

Capacitance is a _____ of the ability to store _____ energy.

measurement electrical

8. Select the best definition of resistance.

A. Resistance is the opposition to the flow of current.
B. Resistance is the amount of electrons flowing through a circuit.
C. Resistance is a difference of potential.
D. Resistance is a measurement of the ability to store electrical energy.
E. Resistance is the same as pressure.

A

9. "A difference of potential" is the definition for which of the following?

A. Current.
B. Electromotive force.
C. Resistance.
D. An electron.
E. An atom.

B

10. **Inductance is a measurement of the ability to store magnetic energy.**

An inductor is formed by a coil of wire. The diameter, length, and number of turns of the coil determine the amount of inductance. The proximity to a nearby conductor also has an effect on a coil's inductance.

Inductance is a _____ of the ability to store _____ energy.

measurement magnetic

11. Select the best definition of capacitance.

A. Capacitance is a measurement of a difference of potential.
B. Capacitance is a measurement of the ability to store mechanical energy.
C. Capacitance is a measurement of the ability to store electrical energy.
D. Capacitance is the opposition to the flow of current.
E. Capacitance is the amount of voltage in a circuit.

C

12. "The opposition to the flow of current" is the definition for which of the following?

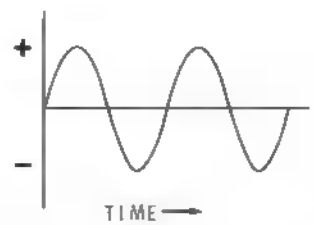
A. Voltage.
B. Capacitance.
C. Inductance.
D. Electromotive force.
E. Resistance.

E

13. **Alternating current (AC) is a current flow that changes direction at a given rate.**

AC is caused by a voltage source that alternately changes polarity ("+" terminal changes to "−", "−" terminal changes to "+", etc.). The rate at which the current changes directions is called the frequency. Figure 5-4 shows an AC wave that changes polarity at regular intervals.

Figure 5-4



Alternating current (AC) is a _____ flow that changes _____ at a given rate.

current direction

14. Select the best definition of inductance.

A. Inductance is a measurement of the ability to store electrical energy.
B. Inductance is a measurement of the ability to store magnetic energy.
C. Inductance is a measurement of ■ difference of potential.
D. Inductance is the opposition to the flow of current.
E. Inductance is ■ measurement of the current used in a circuit.

B

15. "The ability to store electrical energy" is the definition for which of the following?

A. Capacitance.
B. Inductance.
C. Potential difference.
D. Current.
E. Resistance.

A

16. **The hertz (Hz) is the basic unit of measurement for frequency, and it equals 1 cycle per second.**

One cycle per second (see Figure 5-5) means that ■ wave makes ■ complete alternation in one second of time.

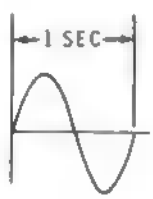


Figure 5-5

The hertz (Hz) is the basic unit of measurement for _____, and it equals one _____ per _____.

frequency cycle second

17. Which of the following is the best definition of alternating current (AC)?

A. Alternating current is a current flow that changes from AC to DC at a given rate.
B. Alternating current is a flow of voltage that changes direction at a given rate.
C. Alternating current is a current flow that flows in one direction.
D. Alternating current (AC) is a current flow that changes direction at a given rate.
E. Alternating current is a current flow that is interrupted.

D

18. "The ability to store magnetic energy" is the definition for which of the following?

A. Capacitance.
B. Inductance.
C. Resistance.
D. Potential difference.
E. Current.

B

19. **A kilohertz (kHz) is 1000 hertz (1000 cycles per second).**

A kilohertz is _____ hertz.

1000

20. What is the basic unit of measurement for frequency that equals 1 cycle per second called?

A. The kilohertz.
B. The megahertz.
C. The hertz.
D. The kilocycle.
E. The megacycle.

C

21. "A current flow that changes direction at a given rate" is the definition for which of the following?

A. Alternating current.
B. Direct current.
C. Frequency modulation.
D. Amplitude modulation.
E. None of the above.

A

22. **A megahertz (MHz) is 1,000,000 hertz (1,000,000 cycles per second).**

A megahertz is _____ hertz.

1,000,000

23. How many hertz is 1 kilohertz?

A. 1.
B. 100.
C. 10.
D. 10,000.
E. 1000.

E

24. Select the basic unit of measurement for frequency.

A. The kilohertz.
B. The kilocycle.
C. The megacycle.
D. The hertz.
E. The megahertz.

D

25. **Direct current (DC) is a current flow that always travels in one direction.**

DC is caused by a voltage source whose polarity ("+" terminal and "−" terminal) always stays the same. A battery is a common example of a direct current source.

Direct current (DC) is a _____ flow that always travels in _____ direction.

current one

26. How many hertz is 1 megahertz?

A. 1000.
B. 1,000,000.
C. 10.
D. 100.
E. 100,000.

B

27. 1000 hertz is equal to how many kilohertz?

A. 10.
B. 100.
C. 1000.
D. 1,000,000.
E. 1.

E

28. **The voltage that appears across a component (or group of components) in a circuit is called voltage drop.**

Voltage drop is proportional to the resistance of a component multiplied by the current flowing through it.

The voltage that appears across a componet (or group of components) in a circuit is called _____ _____.

voltage drop

29. Which of the following is the best definition of direct current (DC)?

A. Direct current is a current flow that changes direction at a given rate.
B. Direct current is a current flow that changes from AC to DC at a given rate.
C. Direct current is a current flow that always travels in one direction.
D. Direct current is a current flow that comes directly from a source.
E. Direct current is a current flow that flows in a straight line.

C

30. 1,000,000 hertz is equal to how many megahertz?

A. 1.
B. 10.
C. 100.
D. 1000.
E. 1,000,000.

A

31. **Electrical power is the rate at which current does work.**

Since the FCC limits the power level of all transmitters, electrical power is an important consideration in the operation of an amateur station.

Electrical power is the _____ at which current does _____.

rate work

32. Which of the following is the best definition of voltage drop?

A. Voltage drop is the voltage that flows through a component in a circuit.
B. Voltage drop is the voltage that a component in a circuit uses.
C. Voltage drop is a reduction in voltage caused by a change in battery voltage.
D. Voltage drop is the voltage that appears across a component in a circuit.
E. None of the above.

D

33. "A current flow that always travels in one direction" is the definition for which of the following?

A. AC.
B. Straight-line current.
C. Alternating current.
D. Direct current.
E. None of the above.

D

34. Since most electronic circuits require direct current (DC) and ordinary house current is alternating current (AC), some process must be used to convert the AC into DC.

The process of changing AC into DC is called "rectification."

The next Module will cover rectification in greater detail.

The process of changing _____ into _____ is called rectification.

AC DC

35. Which of the following is the best definition of electrical power?

A. Electrical power is a current flow that changes direction at a given rate.
B. Electrical power is the rate at which current does work.
C. Electrical power is a current flow that always travels in one direction.
D. Electrical power is the same thing as ordinary house current.
E. Electrical power is the type of current you get only from a battery.

B

36. "The voltage that appears across a component in a circuit" is the definition for which of the following?

A. Alternating current.
B. Direct current.
C. Inductance.
D. Capacitance.
E. Voltage drop.

E

37. **A harmonic is a multiple of a frequency.**

Harmonics are always ■ whole multiple (2×, 3×, 4×, etc.) of a given frequency. The second harmonic of 7 megahertz, for example is 14 megahertz.

A harmonic is a _____ of a frequency.

multiple

38. Which of the following is the best definition of rectification?

A. Rectification is the process of changing DC into AC.
B. Rectification is the process of changing voltage into current.
C. Rectification is the process of changing AC into DC.
D. Rectification is the process of changing current into voltage.
E. Rectification is the process of changing capacitance into inductance.

C

39. "The rate at which current does work" is the definition for which of the following?

A. Potential difference.
B. Electrical power.
C. Inductance.
D. Capacitance.
E. Rectification.

B

40. **The unit of measurement of electromotive force (EMF) is the "volt."**

Electromotive force is usually expressed in volts, millivolts, or microvolts.

The unit of measurement of electromotive force (EMF) is the _____.

volt

41. Which of the following is/are true of a harmonic?

A. A harmonic is a whole multiple of a frequency.
B. A harmonic is an odd multiple of a frequency.
C. A harmonic is an even multiple of a frequency.
D. A harmonic is an even or an odd multiple of a frequency.
E. All of the above.

E

42. "The process of changing AC into DC" is the definition for which of the following?

A. Rectification.
B. Inductance.
C. Capacitance.
D. Potential difference.
E. Alternating current.

A

43. **The unit of measurement of current is the "ampere."**

Current is usually expressed in amperes, milliamperes, or microamperes.

The unit of measurement of current is the _____.

ampere

44. Which of the following is the unit of measurement for electromotive force (EMF)?

A. The ampere.
B. The ohm.
C. The hertz.
D. The volt.
E. The farad.

D

45. Which of the following is true concerning a harmonic?

A. A harmonic is always less than the original frequency.
B. A harmonic is a whole multiple of a frequency.
C. A harmonic is never an even multiple of a frequency.
D. A harmonic is never an odd multiple of a frequency.
E. A harmonic is a fraction of a frequency.

B

46. **The unit of measurement of resistance is the "ohm."**

Resistance is expressed in ohms, kilohms, or megohms.

The unit of measurement of resistance is the _____.

ohm

47. Which of the following is the unit of measurement for current?

A. The farad.
B. The volt.
C. The ampere.
D. The ohm.
E. The hertz.

C

48. The volt is the unit of measurement for which of the following?

A. Capacitance.
B. Current.
C. Inductance.
D. Electromotive force (EMF).
E. Resistance.

D

49. **The unit of measurement for power is the "watt."**

Power is usually expressed in watts, milliwatts, microwatts, and kilowatts.

The unit of measurement for power is the _____.

watt

50. Which of the following is the unit of measurement for resistance?

A. The ohm.
B. The mho.
C. The volt.
D. The watt.
E. The ampere.

A

51. The ampere is the unit of measurement for which of the following?

A. Power.
B. Resistance.
C. Electromotive force (EMF).
D. Inductance.
E. Current.

E

52. **The unit of measurement for inductance is the "henry."**

Inductance is usually measured in henries, millihenries, or microhenries.

The unit of measurement for inductance is the _____.

henry

53. Which of the following is the unit of measurement for power?

A. The volt.
B. The ohm.
C. The watt.
D. The henry.
E. The ampere.

C

54. The ohm is the unit of measurement for which of the following?

A. Capacitance.
B. Resistance.
C. Current.
D. Inductance.
E. Power.

B

55. **The unit of measurement for capacitance is the "farad."**

Capacitance is usually measured in microfarads or picofarads.

The unit of measurement for capacitance is the _____.

farad

56. Which of the following is the unit of measurement for inductance?

A. The farad.
B. The watt.
C. The ohm.
D. The henry.
E. The ampere.

D

57. The watt is the unit of measurement for which of the following?

A. Current.
B. Power.
C. Electromotive force (EMF).
D. Capacitance.
E. Resistance.

B

58. **The potential, or ability, to do electrical work is known as "electrical energy." For example, a battery is a source of electrical energy because it has the ability to do electrical work.**

Electrical energy is similar to power. The main difference is that power is a measure of the amount of work done in a specific period of time.

The amount of electrical work that is available is called _____ _____.

electrical energy

59. Which of the following is the unit of measurement for capacitance?

A. The farad.
B. The henry.
C. The volt.
D. The hertz.
E. The ohm.

A

60. The henry is the unit of measurement for which of the following?

A. Capacitance.
B. Current.
C. Frequency.
D. Power.
E. Inductance.

E

61. Ohm's law states that "current is directly proportional to voltage and inversely proportional to resistance.

Usually, the letter I represents current, E represents voltage, and R represents resistance. Therefore, according to Ohm's law,

$$I = \frac{E}{R}$$

Assume that you have the simple circuit shown below and you want to determine how much current flows through it. (Note the symbols for a battery and resistance.)

SOLUTION:

$$\text{Since } I = \frac{E}{R}, \quad I = \frac{30 \text{ volts}}{10 \text{ ohms}}$$

30 ÷ 10 = 3 amperes (answer)

What would the current in the above circuit be if the resistance was 15 ohms? _____.

2 amperes (30 volts ÷ 15 ohms = 2 amperes)

62. What is the potential, or ability, to do electrical work called?

A. Power.
B. Capacitance.
C. Electrical energy.
D. Electromotive force.
E. Inductance.

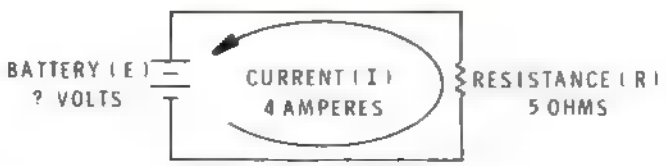
C

63. The farad is the unit of measurement for which of the following?

A. Power.
B. Frequency.
C. Current.
D. Capacitance.
E. Inductance.

D

64. Assume that you have the simple circuit shown below and you want to determine the voltage across it.



SOLUTION: As you learned from Ohm's law, $I = \frac{E}{R}$. If you multiply both sides of the equation by R ($I \times R = \frac{E}{R} \times R$), the R's cancel out on the right side of the equation which leaves the equation for voltage:

$$E = I \times R$$

Since $E = I \times R$, E = 4 amperes × 5 ohms (from above problem)

$4 \times 5 = 20$ volts (answer)

What would the voltage across the above circuit be if the current was 3 amperes? _____.

15 volts (3 amperes × 5 ohms = 15 volts)

65. How much current flows in the circuit shown below?

A. 100 amperes.
B. 1 ampere.
C. 10 amperes.
D. .1 ampere.
E. None of the above.

B (10 volts ÷ 10 ohms = 1 ampere)

66. What is the potential, or ability, to do electrical work called?

A. Capacitance.
B. Inductance.
C. Power.
D. Potential difference.
E. Electrical energy.

E

67. Any circuit that contains resistance dissipates power in the form of heat. The amount of this power can be very small or large, depending on the particular circuit.

The equation for power (in watts) is $P = I \times E$. The letter P is usually used to represent power.

How much power is used in the circuit below?

SOLUTION: Since $P = I \times E$, P = 10 amperes × 20 volts

$10 \times 20 = 200$ watts (answer)

How much power would be used in the above circuit if the current was 5 amperes? _____.

100 watts (5 amperes × 20 volts = 100 watts)

68. How much voltage must be across the circuit below to cause the indicated current to flow?

A. 0.4 volts.
B. 2.5 volts.
C. 1 volt.
D. 100 volts.
E. 10 volts.

E (2 amperes × 5 ohms = 10 volts)

69. How much current flows in the circuit shown below?

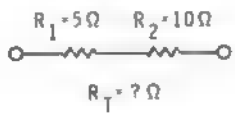
A. 2 amperes.
B. 50 amperes.
C. 0.5 amperes.
D. 5 amperes.
E. 10 amperes.

A (10 volts ÷ 5 ohms = 2 amperes)

70. The circuits covered so far are called series circuits (each component is connected end to end) and contain only one resistance. Actually, there could be any number of resistances (also called "resistors") connected in these series circuits.

To determine the total resistance in a series circuit containing two or more resistors, you simply add the individual resistor values together. Therefore, $R_{T(total)} = R_1 + R_2 + R_3$ + etc.

What is the total resistance of the two resistors shown below? (NOTE: For convenience, the Greek letter Omega, Ω, is used to indicate ohms.)



SOLUTION: Since $R_T = R_1 + R_2$, $R_T = 5\ \Omega + 10\ \Omega$

$5\ \Omega + 10\ \Omega = 15\ \Omega$ (answer)

What is the total resistance of two 10 Ω resistors connected in series? _____.

20 Ω (10 Ω + 10 Ω = 20 Ω)

71. How much power is used in the circuit shown below?

A. 50 watts.
B. 100 watts.
C. 200 watts.
D. 5000 watts.
E. 25 watts.

C (2 amperes × 100 volts = 200 watts)

72. What value of voltage is across the circuit shown below?

A. 33.3 volts.
B. .03 volts.
C. 3000 volts.
D. 300 volts.
E. 3 volts.

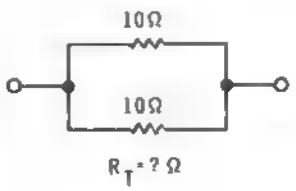
D (3 amperes × 100 Ω = 300 volts)

73. In some cases, resistors are connected in parallel instead of in series.

To determine the total resistance in a parallel circuit containing two or more resistors, you use the equation

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \text{etc.}}$$

What is the total resistance of the two resistors shown below?



SOLUTION: Since $R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2}}$,

$$R_T = \frac{1}{\frac{1}{10\ \Omega} + \frac{1}{10\ \Omega}} = \frac{1}{.2}$$

$$\frac{1}{.2} = 5\ \Omega \text{ (answer)}$$

NOTE: The total resistance of two or more resistors connected in parallel is **always** less than the lowest value resistor.

What is the total resistance of a 10 Ω and a 30 Ω resistor connected in parallel? _____.

7.5 Ω ($\frac{1}{\frac{1}{10} + \frac{1}{30}} = 7.5\ \Omega$)

74. What is the total resistance of three 20 Ω resistors connected in series?

A. 20 Ω.
B. 60 Ω.
C. 40 Ω.
D. 6.667 Ω.
E. 10 Ω.

B (R_T = 20 Ω + 20 Ω + 20 Ω = 60 Ω)

75. How much power is used in the circuit shown below?

A. 500 watts.
B. 250 watts.
C. 50 watts.
D. 10 watts.
E. 2 watts.

B (P = 50 volts × 5 amperes = 250 watts)

76. The same amount of current always flows through each component in a series circuit. This is easy to understand since each component is connected end-to-end throughout the circuit. Therefore, whatever value of current flows through one component must also flow through every other component.

What value of current flows through each resistor in the following circuit?

SOLUTION: Before you can determine the current, you must find the total resistance. Since this is a series circuit, the total resistance is 20 Ω (15 Ω + 5 Ω).

Now to calculate the current, divide the battery voltage by the total resistance.

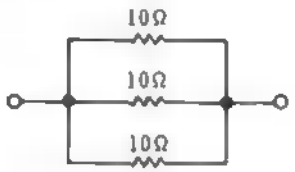
$$I = \frac{E}{R_T} = \frac{40 \text{ volts}}{20\ \Omega} = 2 \text{ amperes (answer)}$$

Since this is a series circuit, this same 2 amperes flows through each resistor.

What value of current would flow through the resistors in the above circuit if the battery voltage was 60 volts? _____.

3 amperes (60 volts ÷ 20 ohms = 3 amperes)

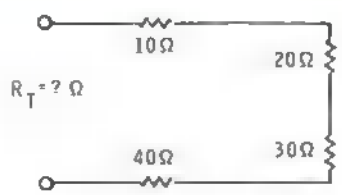
77. What is the total resistance of three 10 Ω resistors connected in parallel?



A. 10 Ω.
B. 30 Ω.
C. 3.33 Ω.
D. 20 Ω.
E. 33.3 Ω.

C $\left(\dfrac{1}{\frac{1}{10}+\frac{1}{10}+\frac{1}{10}} = 3.33\ \Omega\right)$

78. What is the total resistance of the circuit shown below?



A. 100 Ω.
B. .208 Ω.
C. 2.5 Ω.
D. 1000 Ω.
E. 10 Ω.

A (R_T = 10 Ω + 20 Ω + 30 Ω + 40 Ω = 100 Ω)

79. As you were shown earlier, the same amount of current always flows through each component in a series circuit. The voltage that appears across each component, however, is not the same. The amount of voltage that appears across a resistor in a series circuit is directly proportional to the value of the resistor.

Assume that you have the circuit shown below and you want to determine the voltage across each resistor.

SOLUTION: Since the same current (1.6 amperes) flows through each resistor, all you need to do is multiply the current by each resistor value.

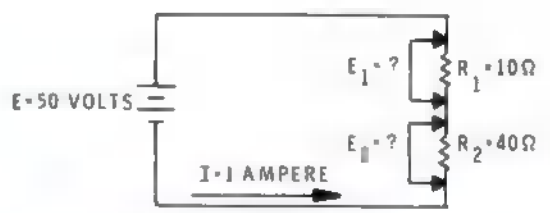
E_1 = 1.6 amperes × 20 Ω = 32 volts (voltage across R_1)

$E_2 = I \times R_2$
E_2 = 1.6 amperes × 30 Ω = 48 volts (voltage across R_1)

NOTE: In series circuit, the voltages across the individual components must add up to the battery voltage ($E_1 + E_2 = E_{battery}$).

How much voltage is across each resistor in the following circuit?

E_1 = _____.
E_2 = _____.



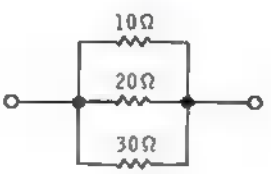
E_1 = 10 volts (10 Ω × 1 ampere)
E_2 = 40 volts (40 Ω × 1 ampere)

80. How much current flows through each resistor in the following circuit?

A. 1.5 amperes.
B. 2.4 amperes.
C. 4 amperes.
D. 9.375 amperes.
E. 0.667 amperes.

A $\left(I = \frac{60}{40} = 1.5 \text{ amperes}\right)$

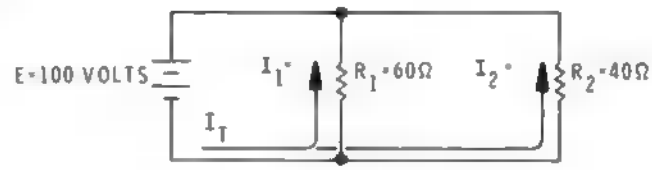
81. What is the total resistance of the following circuit?



A. 6.667 Ω.
B. 60 Ω.
C. 7.5 Ω.
D. 12 Ω.
E. 5.45 Ω.

E $\left(R_t = \frac{1}{\frac{1}{10} + \frac{1}{20} + \frac{1}{30}} = 5.45\ \Omega \text{ approximate}\right)$

82. In contrast to a series circuit, the same amount of current does not necessarily flow through the components in a parallel circuit. As you can see from the circuit below, the current divides before it flows through each branch of the circuit.



What value of current flows through each of the resistors in the above circuit?

SOLUTION: Since the battery is connected directly across each resistor, all that is necessary to determine the current through each resistor is simply divide the battery voltage by each resistor value ($I = \frac{E}{R}$).

Therefore,

$$I_1 = \frac{100 \text{ volts}}{60\ \Omega} = 1.67 \text{ amperes (current through } R_1).$$

$$I_2 = \frac{100 \text{ volts}}{40\ \Omega} = 2.5 \text{ amperes (current through } R_2).$$

To determine the total current (the amount of current the battery supplies), simply add the currents together (1.67 amperes + 2.5 amperes = 4.17 amperes).

As a check, you could determine the total resistance of the two resistors (24 Ω) and then divide the battery voltage (100 V) by this total resistance. The current should be the same (4.17 amperes).

How much current would flow through the resistors in the above circuit if the battery voltage was 150 volts?

I_1 = _____.

I_2 = _____.

I_1 = 2.5 amperes ($I_1 = \frac{150}{60} = 2.5$ amperes)

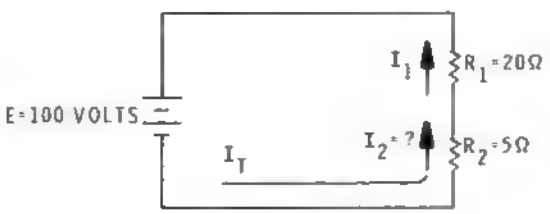
I_2 = 3.75 amperes ($I_2 = \frac{150}{40} = 3.75$ amperes)

83. How much voltage is across resistor R_1 in the following circuit?

A. 50 volts.
B. 100 volts.
C. 40 volts.
D. 60 volts.
E. 24 volts.

D ($E_1 = 30\ \Omega \times 2$ amperes $= 60$ volts)

84. How much current flows through resistor R_2 in the following circuit?



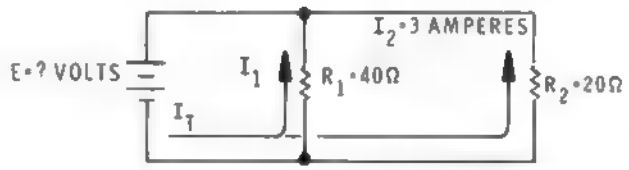
A. 5 amperes.
B. 4 amperes.
C. 20 amperes.
D. 25 amperes.
E. Can't be determined with information given.

B

($I_2 = \frac{100}{25} = 4$ amperes.)

NOTE: Since this is a series circuit, the current is the same everywhere in the circuit.

85. As you were shown in the discussion of the current through a parallel circuit, the same voltage appears across each branch of a parallel circuit. To determine the battery voltage in the following circuit, all that is necessary is to find the voltage across either resistor. What is the battery voltage in the circuit?



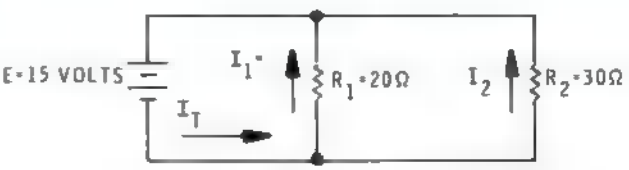
SOLUTION: Since the voltage is the same everywhere in a parallel circuit, $E = E_2$. $E_2 = 3$ amperes $\times$ 20 Ω = 60 volts. Therefore, E = 60 volts (answer).

What would the battery voltage be if the current through resistor R_2 was 4 amperes?

E = _____.

80 volts (4 amperes × 20 Ω = 80 volts)

86. How much current flows through resistor R_1 in the following circuit?



A. 0.3 amperes.
B. 12 amperes.
C. 0.5 ampere.
D. 0.75 ampere.
E. 1.5 amperes.

D ($I_1 = \frac{15}{20} = 0.75$ ampere)

87. What is the battery voltage in the following circuit?

A. Can't be determined.
B. 45 volts.
C. 150 volts.
D. 105 volts.
E. 31.5 volts.

C $(E = I \times R_T = 3 \times 50 = 150 \text{ volts})$

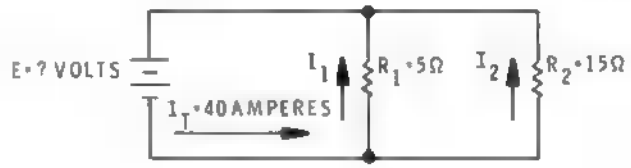
88. **The invisible lines of force that surround a magnet are called a "magnetic field."**

This magnetic field is what actually causes two magnets to attract or repel each other. A magnetic field also causes a magnet to attract small pieces of iron or steel.

The invisible lines of force that surround a magnet are called a _____ _____.

magnetic field

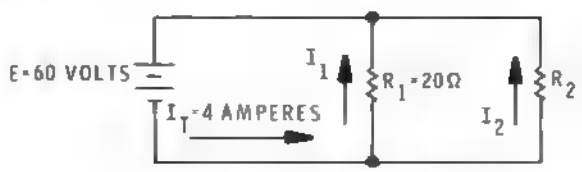
89. What is the battery voltage in the following circuit?



A. 150 volts.
B. 200 volts.
C. 600 volts.
D. 800 volts.
E. Can't be determined.

A (Since only the total current is given, you must first find the total resistance which is 3.75 Ω. Then you multiply the total current by the total resistance to obtain 150 volts.)

90. How much current flows through resistor R_2 in the following circuit?



A. Can't be determined.
B. 1 ampere.
C. 4 amperes.
D. 3 amperes.
E. 12 amperes.

B (First determine the current through R_1. To do this, divide 60 volts by 20 Ω and obtain 3 amperes. Since the total current in a parallel circuit must equal the currents through the branches, subtract the current through R_1 from the total current to find the current through R_2.)

91. **The force which produces a magnetic field is called "magnetomotive force."**

When a magnet field is produced by an electromagnet, the amount of force is measured in gilberts and is equal to 1.26 × the number of turns in the coil × the current in amperes that is flowing in the coil (1.26 × N × I).

The force which produces a magnetic field is called _____ _____.

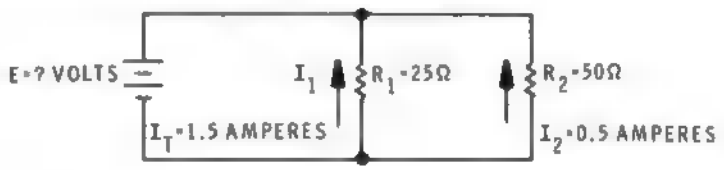
magnetomotive force.

92. Which of the following is the best definition of a magnetic field?

A. A magnetic field is formed by the visible lines of force that surround a magnet.
B. A magnetic field is formed by the invisible lines of force that surround any metallic object.
C. A magnetic field is formed by the invisible lines of force that surround any iron or steel object.
D. A magnetic field is formed by the invisible lines of force that surround a magnet.
E. None of the above.

D

93. What is the battery voltage in the following circuit?



A. 75 volts.
B. 37.5 volts.
C. 100 volts.
D. 112.5 volts.
E. 25 volts.

E (E = 50 Ω × 0.5 amperes = 25 volts)

94. Which of the following is the best definition of magnetomotive force?

A. Magnetomotive force is the invisible lines of force that surround a magnet.
B. Magnetomotive force is the force which reduces a magnetic field.
C. Magnetomotive force is the force which produces a magnetic field.
D. Magnetomotive force is a force that is only produced by an electromagnet.
E. Magnetomotive force is a force that is only produced by a magnetic material.

C

95. Select the best definition of a magnetic field.

A. A magnetic field is produced by the invisible lines of force that surround a magnet.
B. A magnetic field is formed by the invisible lines of force that surround any metallic object.
C. A magnetic field is formed by the invisible lines of force that surround any iron or steel object.
D. A magnetic field is formed by the visible lines of force that surround a magnet.
E. None of the above.

A

96. Select the best definition of magnetomotive force.

A. Magnetomotive force is a force which reduces a magnetic field.
B. Magnetomotive force is a force which produces a magnetic field.
C. Magnetomotive force is a force that is only produced by magnetic material.
D. Magnetomotive force is a force that is only produced by an electromagnet.
E. Magnetomotive force is the invisible lines of force that surround a magnet.

B

MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers," which follows.

- If you miss more than six questions, go back and re-read this whole module.

- If you have less than six incorrect answers, go back and study those frames pertaining to the questions you missed (the number in the parentheses following the correct answer refers you to the proper frame). Then proceed to the next module.

1. Select the best definition of current.

   A. A difference of potential.
   B. The opposition to the flow of electrons.
   C. The ability to store electrical energy.
   D. The amount of electrons flowing through a circuit.
   E. The ability to store magnetic energy.

2. Which of the following best describes electromotive force?

   A. The amount of electrons flowing through a circuit.
   B. A difference potential.
   C. The opposition to the flow of current.
   D. An electron.
   E. An atom.

3. Which of the following best describes resistance?

   A. A difference of potential.
   B. The ability to store electrical energy.
   C. The ability to store magnetic energy.
   D. An electromotive force.
   E. The opposition to the flow of current.

4. Select the best definition of capácitance.

   A. The ability to store electrical energy.
   B. The ability to store magnetic energy.
   C. A difference of potential.
   D. The amount of electrons flowing through a circuit.
   E. The opposition to the flow of current.

5. Which of the following best describes inductance?

   A. The ability to store electrical energy.
   B. The ability to store magnetic energy.
   C. The opposition to the flow of current.
   D. A difference of potential.
   E. The amount of electrons flowing through a circuit.

6. Select the best definition of alternating current.

   A. A current flow that changes direction at a given rate.
   B. A current flow that always flows in one direction.
   C. A frequency modulated wave.
   D. An amplitude modulated wave.
   E. None of the above.

7. Which of the following is the **basic** unit of measurement for frequency?

   A. The kilohertz.
   B. The kilocycle.
   C. The megacycle.
   D. The hertz.
   E. The megahertz.

8. How many hertz are in one kilohertz?

   A. 10.
   B. 100.
   C. 1000.
   D. 1,000,000.
   E. 1.

9. How many hertz are in one megahertz?

A. 1.
B. 10.
C. 100.
D. 1000.
E. 1,000,000.

10. Which of the following best describes direct current?

A. A current flow that changes direction at a given rate.
B. A current flow that always travels in a straight line.
C. A current flow that comes straight from the source.
D. A current flow that always flows in one direction.
E. None of the above.

11. Select the best definition of voltage drop.

A. A change in voltage due to a short circuit.
B. A change in voltage due to an open circuit.
C. The voltage that appears only across an inductance.
D. The voltage that appears only across a capacitance.
E. The voltage that appears across any component in a circuit.

12. Which of the following best describes electrical power?

A. A difference of potential.
B. The rate at which current does work.
C. The ability to store electrical energy.
D. The ability to store magnetic energy.
E. The ability of a circuit to change AC to DC.

13. Select the best definition of rectification.

A. The process of changing AC into DC.
B. The ability to change inductance into capacitance.
C. The ability to change capacitance into inductance.
D. The ability to correct a problem.
E. The process of changing DC into AC.

14. Which of the following best describes a harmonic?

A. A frequency that is less than an original frequency.
B. A frequency that is a whole multiple of an original frequency.
C. A frequency that is an even multiple of another frequency.
D. A frequency that is an odd multiple of another frequency.
E. A frequency that is a fraction of another frequency.

15. What is the unit of measurement for electromotive force?

A. The farad.
B. The ampere.
C. The henry.
D. The volt.
E. The ohm.

16. What is the unit of measurement for current?

A. The watt.
B. The ohm.
C. The volt.
D. The henry.
E. The ampere.

17. What is the unit of measurement for resistance?

A. The farad.
B. The ohm.
C. The ampere.
D. The henry.
E. The watt.

18. What is the unit of measurement for power?

A. The ampere.
B. The watt.
C. The volt.
D. The farad.
E. The ohm.

19. What is the unit of measurement for inductance?

A. The farad.
B. The ampere.
C. The hertz.
D. The watt.
E. The henry.

20. What is the unit of measurement for capacitance?

A. The watt.
B. The hertz.
C. The ampere.
D. The farad.
E. The henry.

21. Which of the following best describes electrical energy?

A. The ability to store electrical work.
B. The ability to store magnetic work.
C. The ability to dissipate work.
D. The ability to store voltage.
E. The ability to do electrical work.

22. How much current flows in the circuit shown below?

A. 2 amperes.
B. 50 amperes.
C. 0.5 amperes.
D. [illegible] amperes.
E. 10 amperes.

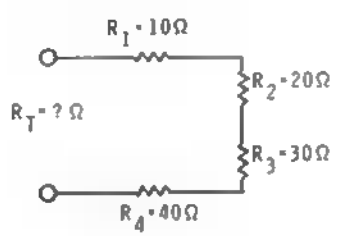
23. What is the battery voltage in the circuit shown below?

A. 33.3 volts.
B. .03 volts.
C. 3000 volts.
D. 300 volts.
E. 3 volts.

24. How much power is used in the circuit shown below?

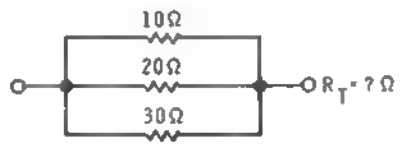
A. 500 watts.
B. 250 watts.
C. 50 watts.
D. 10 watts.
E. 2 watts.

25. What is the total resistance of the circuit shown below?



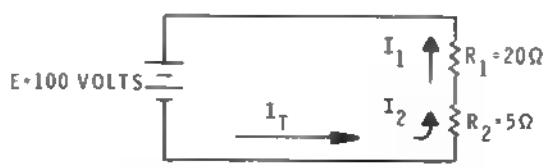
A. 100 Ω.
B. .208 Ω.
C. 2.5 Ω.
D. 1000 Ω.
E. 10 Ω.

26. What is the total resistance of the following circuit?



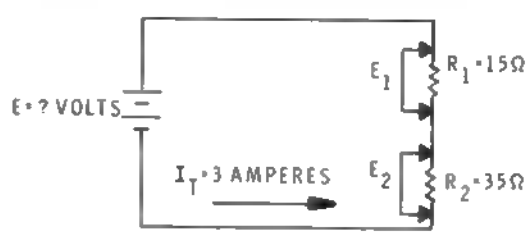
A. 6.667 Ω.
B. 60 Ω.
C. 7.5 Ω.
D. 12 Ω.
E. 5.45 Ω.

27. How much current flows through resistor R_2 in the following circuit?



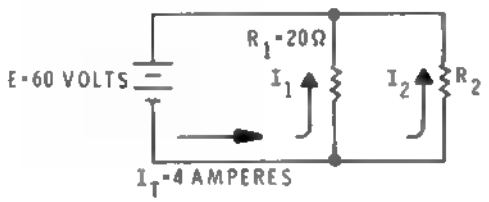
A. 5 amperes.
B. 4 amperes.
C. 20 amperes.
D. 25 amperes.
E. Can't determine from information given.

28. What is the battery voltage in the following circuit?



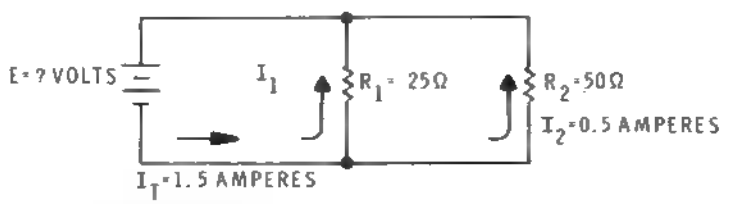
A. Can't be determined.
B. 45 volts.
C. 150 volts.
D. 105 volts.
E. 31.5 volts.

29. How much current flows through resistor R_2 in the following circuit?



A. Can't be determined.
B. 1 ampere.
C. 4 amperes.
D. 3 amperes.
E. 12 amperes.

30. What is the battery voltage in the following circuit?



A. 75 volts.
B. 37.5 volts.
C. 100 volts.
D. 112.5 volts.
E. 25 volts.

31. Select the best definition of a magnetic field.

A. A magnetic field is produced by the invisible lines of force that surround a magnet.
B. A magnetic field is formed by the invisible lines of force that surround any metallic object.
C. A magnetic field is formed by the invisible lines of force that surround any iron or steel object.
D. A magnetic field is formed by the visible lines of force that surround a magnet.
E. None of the above.

32. Select the best definition of magnetomotive force.

A. Magnetomotive force is a force which reduces a magnetic field.
B. Magnetomotive force is a force which produces a magnetic field.
C. Magnetomotive force is a force that is only produced by magnetic material.
D. Magnetomotive force is a force that is only produced by an electromagnet.
E. Magnetomotive force is the invisible lines of force that surround a magnet.

EXAMINATION ANSWERS

Q	A	FRAME NO.
1.	D.	(1)
2.	B.	(2)
3.	E.	(4)
4.	A.	(7)
5.	B.	(10)
6.	A.	(13)
7.	D.	(16)
8.	C	(19)
9.	E.	(22)
10.	D.	(25)
11.	E.	(28)
12.	B.	(31)
13.	A.	(34)
14.	B.	(37)
15.	D.	(40)
16.	E.	(43)
17.	B.	(46)
18.	B.	(49)
19.	E.	(52)
20.	D.	(55)
21.	E.	(58)
22.	A.	(61)
23.	D.	(64)
24.	B.	(67)
25.	A.	(70)
26.	E.	(73)
27.	B.	(76)
28.	C.	(79)
29.	B.	(82)
30.	E.	(85)
31.	A.	(88)
32.	B.	(91)

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Module 6

CIRCUIT COMPONENTS

ER-3701

HEATH COMPANY
BENTON HARBOR, MICHIGAN 49022

MODULE OBJECTIVES

When you complete this module, you will be able to select:

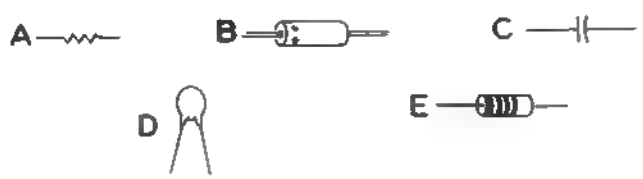
1. The symbol of a resistor.
2. The symbol of a capacitor.
3. The symbol of a crystal.
4. The symbol of an air core and an iron core inductor.
5. The symbol of an air core and an iron core transformer.
6. The symbol of a diode.
7. The symbol of a zener diode.
8. The symbol of a tunnel diode.
9. The symbols of a PNP and an NPN transistor.
10. The symbols of a diode tube, a triode, a tetrode, and a pentode tube.
11. The direction of current flow in a tube.
12. The symbol of a voltmeter.
13. The symbol of an ammeter.
14. The symbol of an ohmmeter.

MODULE PRETEST

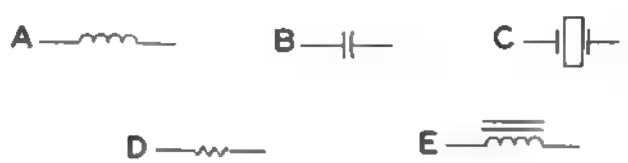
This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Pretest Answers," which follows.

- If you miss more than three questions read this whole module.
- If you have less than three incorrect answers, you may either study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer, refers you to the proper frame) or, you can skip this module and proceed to the next module.

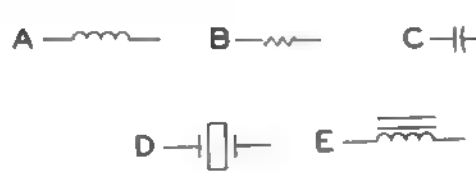
1. Select the symbol of a resistor.



2. Which of the following is the symbol of a capacitor?

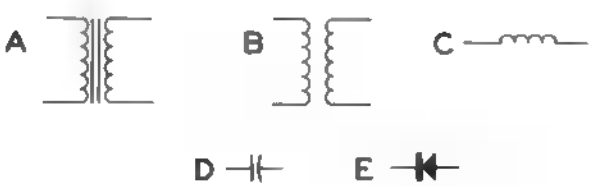


3. Select the symbol of a crystal.

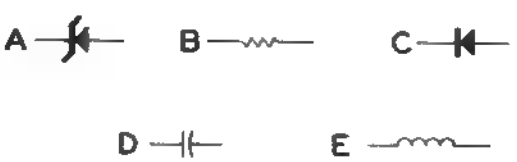


4. Which of the following is the symbol of an iron core inductor?

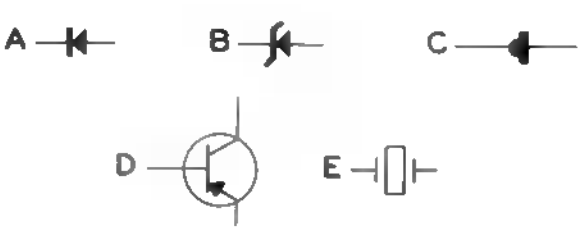
5. Select the symbol of an iron core transformer.



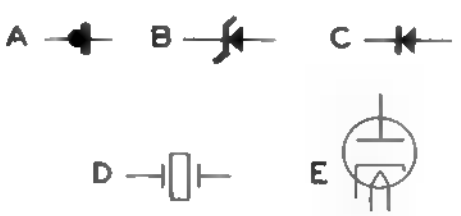
6. Which of the following is the symbol of an ordinary diode?



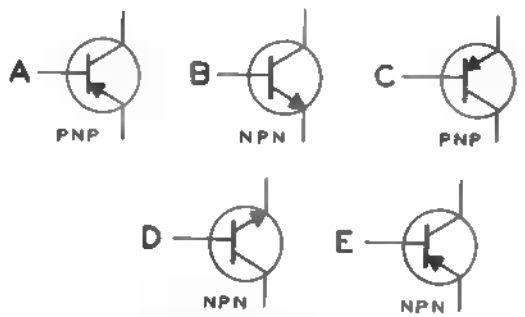
7. Select the symbol of a zener diode.



8. Which of the following is the symbol of a tunnel diode?

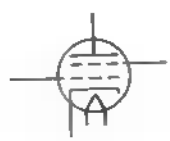


9. Select the symbol that is **not** labeled correctly.



10. What type of tube is shown below?

A. Pentode.
B. Triode.
C. Diode
D. Tetrode.
E. Heptode.

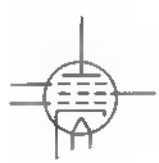


11. What type of tube is shown below?

A. Pentode.
B. Triode.
C. Diode.
D. Tetrode.
E. Heptode.

12. What type of tube is shown below?

A. Pentode.
B. Triode.
C. Diode.
D. Tetrode.
E. Pentagrid.



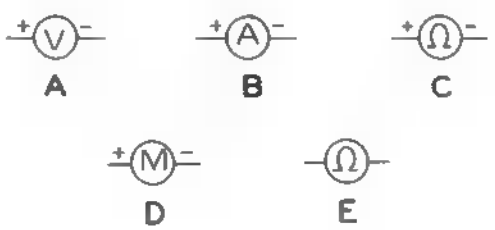
13. What type of tube is shown below?

A. Pentode.
B. Triode.
C. Diode.
D. Tetrode.
E. Heptode.

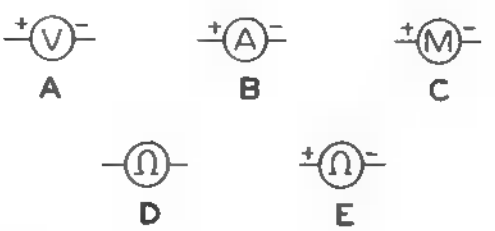
14. Select the true statement concerning the current flow in a vacuum tube.

A. Current flows from grid to plate.
B. Current flows from grid to cathode.
C. Current flows from plate to cathode.
D. Current flows from cathode to plate.
E. Current flows from plate to grid.

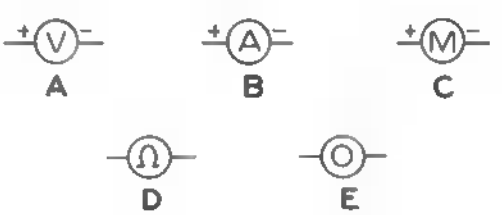
15. Select the symbol of a voltmeter.



16. Select the symbol of an ammeter.



17. Select the symbol of an ohmmeter.



PRETEST ANSWERS

Q	A	FRAME NO.
1.	A	(1)
2.	B	(2)
3.	D	(4)
4.	B	(7)
5.	A	(10)
6.	C	(13)
7.	[redacted]	(16)
8.	A	(19)
9.	E	(22)
10.	D	(25)
11.	[redacted]	(25)
12.	A	(25)
13.	C	(25)
14.	D	(28)
15.	A	(31)
16.	B	(34)
17.	D	(37)

INTRODUCTION

In an earlier module you learned that abbreviations are used quite often to shorten radio messages. Symbols are used in much the same way to shorten or simplify the wiring diagrams (called schematics) of radio equipment.

This module will teach you the symbols of many common radio components.

PROGRAMMED INSTRUCTION

1. As you learned earlier, a component which opposes the flow of current is called a resistor.

   Figure 6-1, Part A, shows a typical resistor while Part B shows its symbol.

Part A *Part B*

Figure 6-1

Resistors often have color bands which give their value in ohms, kilohms, or megohms.

Draw the symbol of a resistor.

2. A component which stores electrical energy is called a capacitor. Capacitors block the flow of direct current (DC) but allow alternating current (AC) to pass.

   Figure 6-2, Part A, shows some typical capacitors and Part B shows the basic symbol of a capacitor.

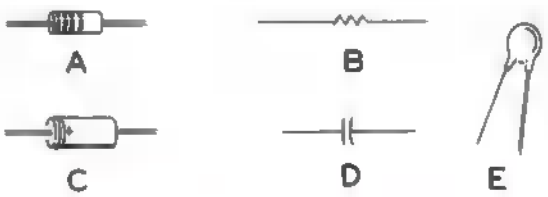
Part A *Part B*

Figure 6-2

Capacitors usually have their value in microfarads (μF) or picofarads (pF) and their voltage rating printed on them.

Draw the basic symbol of a capacitor.

3. Which of the following is the **symbol** of a resistor?



B

4. A component which will vibrate at a specific frequency when it is excited is called a crystal. A crystal may be excited by either pressure or a signal. Transmitters and receivers that require high frequency accuracy and stability often use crystal control.

Figure 6-3, Part A, shows a typical crystal and Part B shows its symbol.

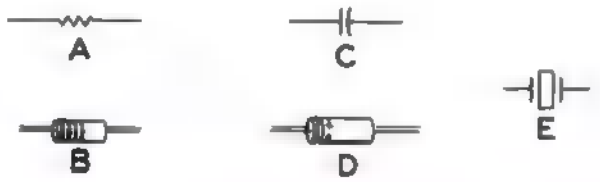
Part A *Part B*

Figure 6-3

Crystals are usually marked with their oscillation frequency, operating frequency, or channel number.

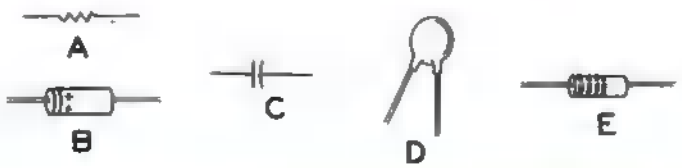
Draw the symbol of a crystal.

5. Select the symbol of a capacitor.



C

6. Which of the following is the symbol of a resistor?



A

7. Earlier, you learned what inductance is. A component which exhibits inductance is called an inductor and is usually in the form of a coil.

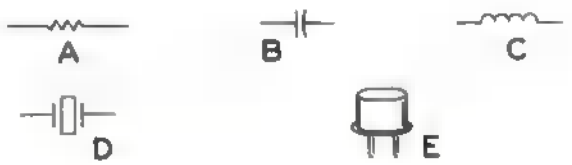
Inductors have many forms; several of them are shown in Figure 6-4, Part A. Part B shows the symbols for air core and iron core inductors.

Figure 6-4

Inductors are measured in henries, millihenries (mH), or microhenries (μH).

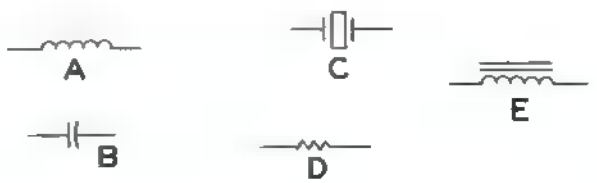
Draw the symbols of an air core and an iron core inductor and label them.

8. Select the symbol of a crystal.



D

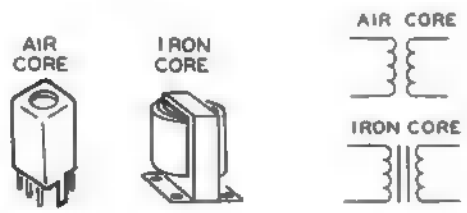
9. Which of the following is the symbol of a capacitor?



B

10. If you place two inductors near each other, you have a transformer. If the two inductors are separated by air, you have an air core transformer. If the two inductors are wound on an iron core, either next to each other or one on top of the other, you have an iron core transformer.

Figure 6-5, Part A, shows two typical transformers. Part B shows the symbol for each type.



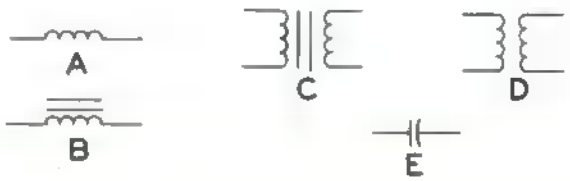
Part A *Part B*

Figure 6-5

Transformers are usually described by the ratio between the inductors with reference to the number of turns, voltage, current, or impedance (resistance). Transformers are not necessarily limited to two inductors. A color television transformer, for example, could have as many as five separate inductors.

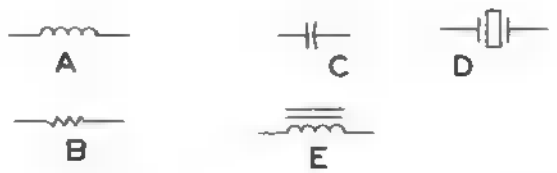
Draw the symbols of an air core and an iron core transformer and label them.

11. Select the symbol of an air core inductor.



A

12. Which of the following is the symbol of a crystal?



D

13. A component which has the capability of conducting in only one direction is called a diode. Diodes play an important role in electrical equipment, as you will learn in the next module.

Figure 6-6, Part A, shows some typical diodes, while Part B shows the symbol of a diode.

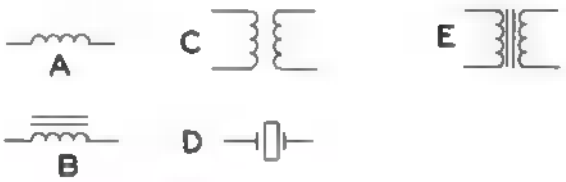
Part A *Part B*

Figure 6-6

Diodes are usually specified by type, current rating, and voltage rating.

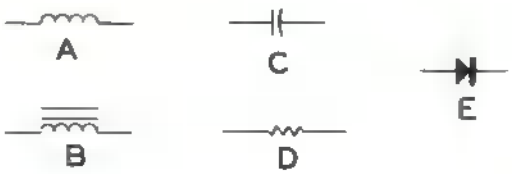
Draw the symbol of a diode.

14. Select the symbol of an air core transformer.



C

15. Which of the following is the symbol of an iron core inductor?



B

16. A diode which has the ability to regulate (hold constant) a voltage is called a zener diode.

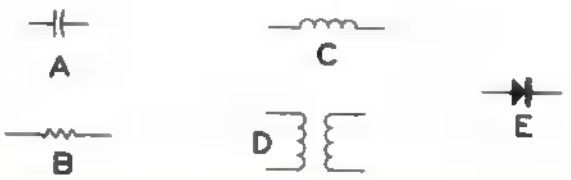
A zener diode looks the same physically as the ordinary diode discussed earlier. Figure 6-7 shows the symbol of a zener diode.

Figure 6-7

Zener diodes are usually specified in voltage and wattage.

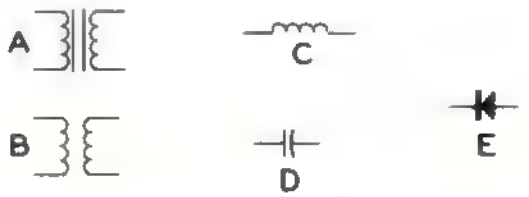
Draw the symbol of a zener diode.

17. Which of the following is the symbol of a diode?



E

18. Select the symbol of an iron core transformer.



A

19. A diode which is capable of operating at high speeds is called a tunnel diode. Due to their high speed, tunnel diodes are often used in electronic switches or high frequency oscillator circuits.

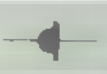
Figure 6-8, Part A, shows a typical tunnel diode and Part B shows its most common symbol.

Part A *Part B*

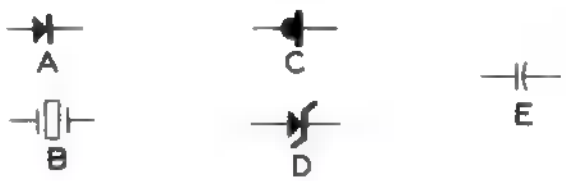
Figure 6-8

Tunnel diodes are usually specified by their current rating.

Draw the symbol of a tunnel diode.

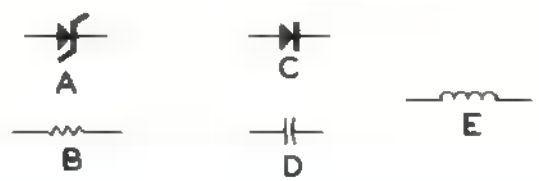


20. Which of the following is the symbol of a zener diode?



D

21. Select the symbol of an ordinary diode.

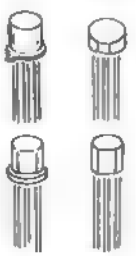


C

22. Diodes are called semiconductors because they are made from materials which are neither conductors or insulators. Another type of semiconductor is the transistor. The major difference between a transistor and a diode is the transistor's ability to amplify. A transistor usually has three leads (or connections) which are called the emitter, the base, and the collector.

There are two basic types of transistors which are called the PNP type and the NPN type. The use of each type of transistor depends upon the circuit characteristics.

Figure 6-9, Part A, shows some typical transistor packages, while Part B shows the symbol for each transistor type. Note that the only difference between the symbols is the direction of the arrowhead on one of the leads.



Part A

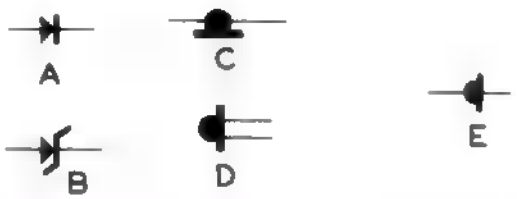
Part B

Figure 6-9

Although transistors are specified in many ways, probably the most important quality of a transistor is its gain (amplification).

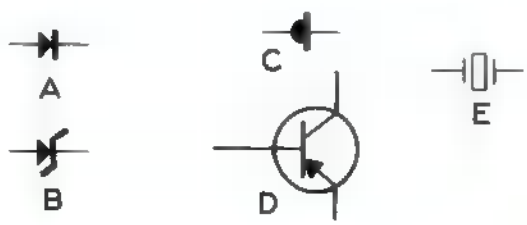
Draw the symbols of the two types of transistors and label them.

23. Select the symbol of a tunnel diode.



E

24. Which of the following is the symbol of a zener diode?



B

25. Vacuum tubes, more commonly called "tubes," are available in many different forms depending upon their use.

The elements, or parts, of a tube are called the plate, the grid(s), and the cathode. Another part of a tube called the heater (or filament) is not normally classified as an element unless the tube does not have a cathode. Figure 6-10 shows a tube and the name given each part.

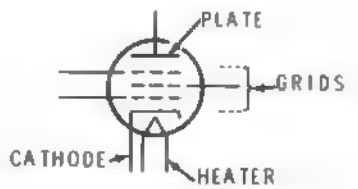


Figure 6-10

The symbols of the four basic types of tubes are shown in Figure 6-11. Note that the name of each type corresponds to the number of elements within the tube. The heater may or may not be shown on the symbol of a tube.

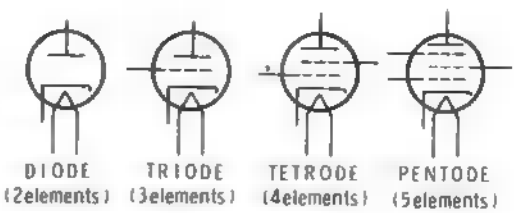
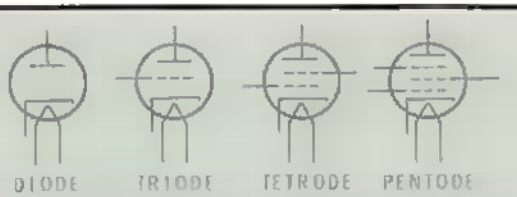


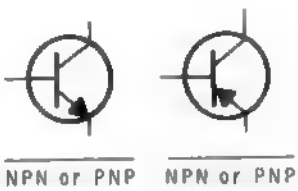
Figure 6-11

It is not necessary for you to remember the names given the elements within a tube at this time. You should, however, be able to name each type of tube when you are given its symbol.

Draw the symbols of the four main types of tubes and label them.

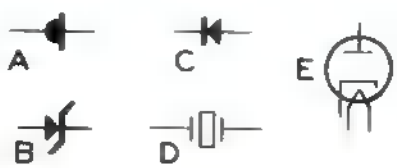


26. Label the following transistor symbols by type (NPN or PNP).



NPN PNP

27. Which of the following is the symbol of a tunnel diode?



A

28. One of the main purposes of a tube is to amplify (make larger) a voltage or signal. A tube accomplishes this by controlling the amount of current flow through the tube. Normally, a tube is connected as shown in Figure 6-12. Note that the plate is positive (+) with respect to the cathode (−).

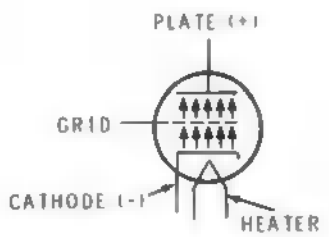


Figure 6-12

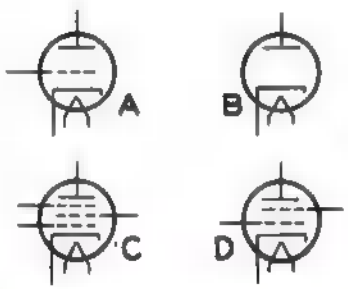
The operation of a vacuum tube is quite simple. The heater heats the cathode and causes electrons to be boiled off. These electrons are then attracted to the highly positive plate of the tube. The grid, in this case called a "control" grid, affects the amount of electron (current) flow much the same as a faucet controls the water flow from a pipe. A small change in control grid voltage causes a large change in plate voltage.

The main thing to remember is that the current flows from the cathode to the plate of a tube.

Current flows from the _____ to the _____ of the tube.

cathode plate

29. Write the letters, beside the tube symbols in the left column, in the corresponding blanks in the right column.



Diode _____

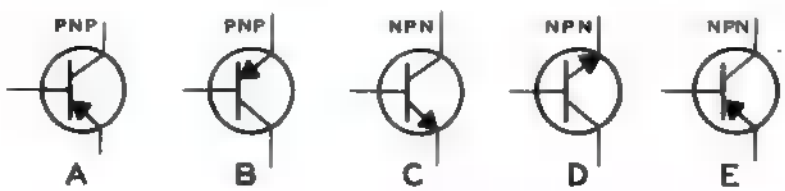
Triode _____

Tetrode _____

Pentrode _____

B
A
D
C

30. Which of the following symbols is **not** labeled correctly?



E

31. A voltmeter is used to measure electromotive force (EMF) or a difference of potential. Figure 6-13 shows the symbol of a voltmeter.

Figure 6-13

Draw the symbol of a voltmeter.

32. Which of the following statements is true concerning current flow in a vacuum tube?

A. Current flows from plate to cathode.
B. Current flows from grid to plate.
C. Current flows from cathode to plate.
D. Current flows from cathode to grid.
E. Current flows from plate to grid.

C

33. How many elements do each of the following tubes have?

Triode _____
Pentode _____
Diode _____
Tetrode _____

3
5
2
4

34. An ammeter is used to measure current. Figure 6-14 shows the symbol of an ammeter.

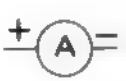
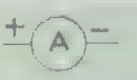
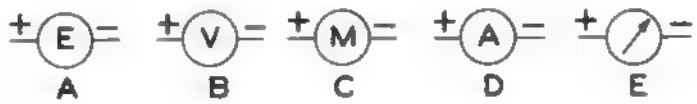


Figure 6-14

Draw the symbol of an ammeter.



35. Select the symbol of a voltmeter.



B

36. Which of the following statements is true concerning the current flow in a vacuum tube?

A. Current flows from grid to plate.
B. Current flows from cathode to grid.
C. Current flows from plate to cathode.
D. Current flows from cathode to plate.
E. Current flows from plate to grid.

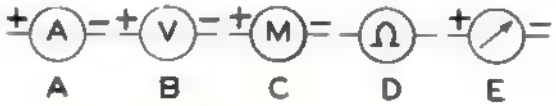
D

37. An ohmmeter is used to measure resistance. Figure 6-15 shows the symbol of an ohmmeter.

Figure 6-15

Draw the symbol of an ohmmeter.

38. Select the symbol of an ammeter.



A

39. What kind of meter is shown below?

A. A voltmeter.
B. An ammeter.
C. A current meter.
D. An ohmmeter.
E. A volume meter.

A

40. Select the symbol of an ohmmeter.

A ■ C D E

B

41. What kind of meter is shown below?

A. An amplitude meter.
B. A voltmeter.
C. An ammeter.
D. An ohmmeter.
E. An acoustic meter.

C

42. What kind of meter is shown below?

A. A curve meter.
B. An ohmmeter.
C. A mhometer.
D. A voltmeter.
E. An all-purpose meter.

B

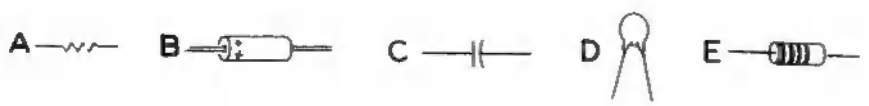
Proceed to the audio "Review of Circuit Components" (Tape 1, Side B).

MODULE EXAMINATION

This examination will test your knowledge of the material presented in this module. For each question, circle the multiple choice answer (A, B, C, D, or E) you feel is most correct. When you have completed these questions, compare your answers with the correct ones that appear under "Examination Answers," which follows.

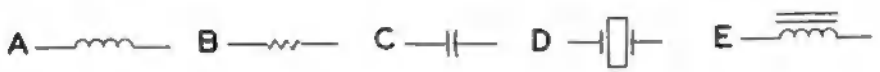
- If you miss more than three questions, go back and re-read this whole module.
- If you have less than three incorrect answers, go back and study those frames pertaining to the questions you missed (the number in parentheses, following the correct answer refers you to the proper frame). Then proceed to the next module.

1. Select the symbol of a resistor.

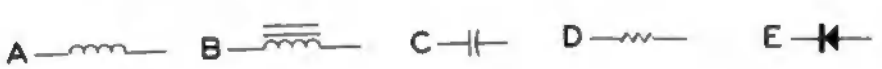


2. Which of the following is the symbol of a capacitor?

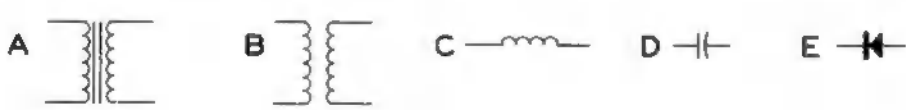
3. Select the symbol of a crystal.



4. Which of the following is the symbol of an iron core inductor?

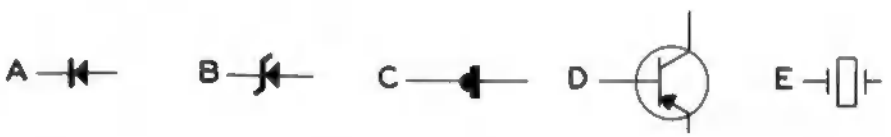


5. Select the symbol of an iron core transformer.

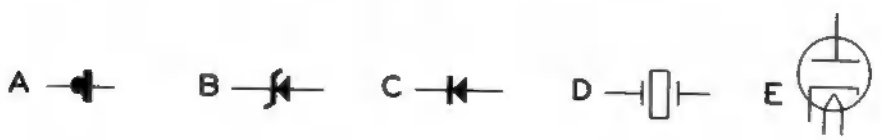


6. Which of the following is the symbol of an ordinary diode?

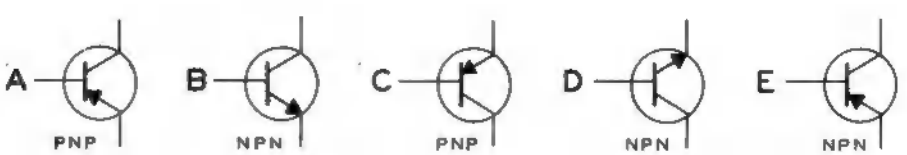
7. Select the symbol of a zener diode.



8. Which of the following is the symbol of a tunnel diode?

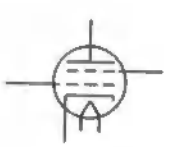


9. Select the symbol that is **not** labeled correctly.



10. What type of tube is shown below?

A. Pentode.
B. Triode.
C. Diode
D. Tetrode.
E. Heptode.

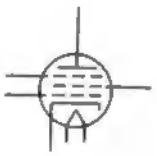


11. What type of tube is shown below?

A. Pentode.
B. Triode.
C. Diode.
D. Tetrode.
E. Heptode.

12. What type of tube is shown below?

A. Pentode.
B. Triode.
C. Diode.
D. Tetrode.
E. Pentagrid.



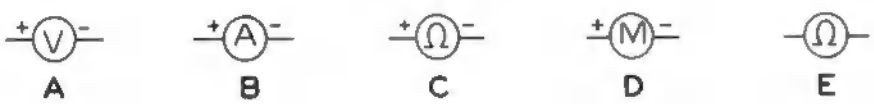
13. What type of tube is shown below?

A. Pentode.
B. Triode.
C. Diode.
D. Tetrode.
E. Heptode.

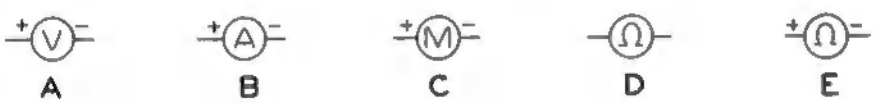
14. Select the true statement concerning the current flow in a vacuum tube.

A. Current flows from grid to plate.
B. Current flows from grid to cathode.
C. Current flows from plate to cathode.
D. Current flows from cathode to plate.
E. Current flows from plate to grid.

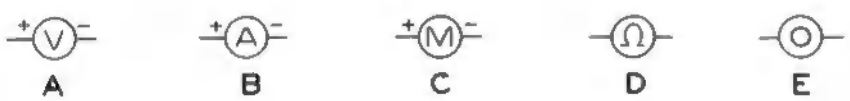
15. Select the symbol of a voltmeter.



16. Select the symbol of an ammeter.



17. Select the symbol of an ohmmeter.



EXAMINATION ANSWERS

Q	A	FRAME NO.
1.	A	(1)
2.	B	(2)
3.	D	(4)
4.	B	(7)
5.	A	(10)
6.	C	(13)
7.	B	(16)
8.	A	(19)
9.	E	(22)
10.	D	(25)
11.	B	(25)
12.	A	(25)
13.	C	(25)
14.	D	(28)
15.	A	(31)
16.	B	(34)
17.	D	(37)